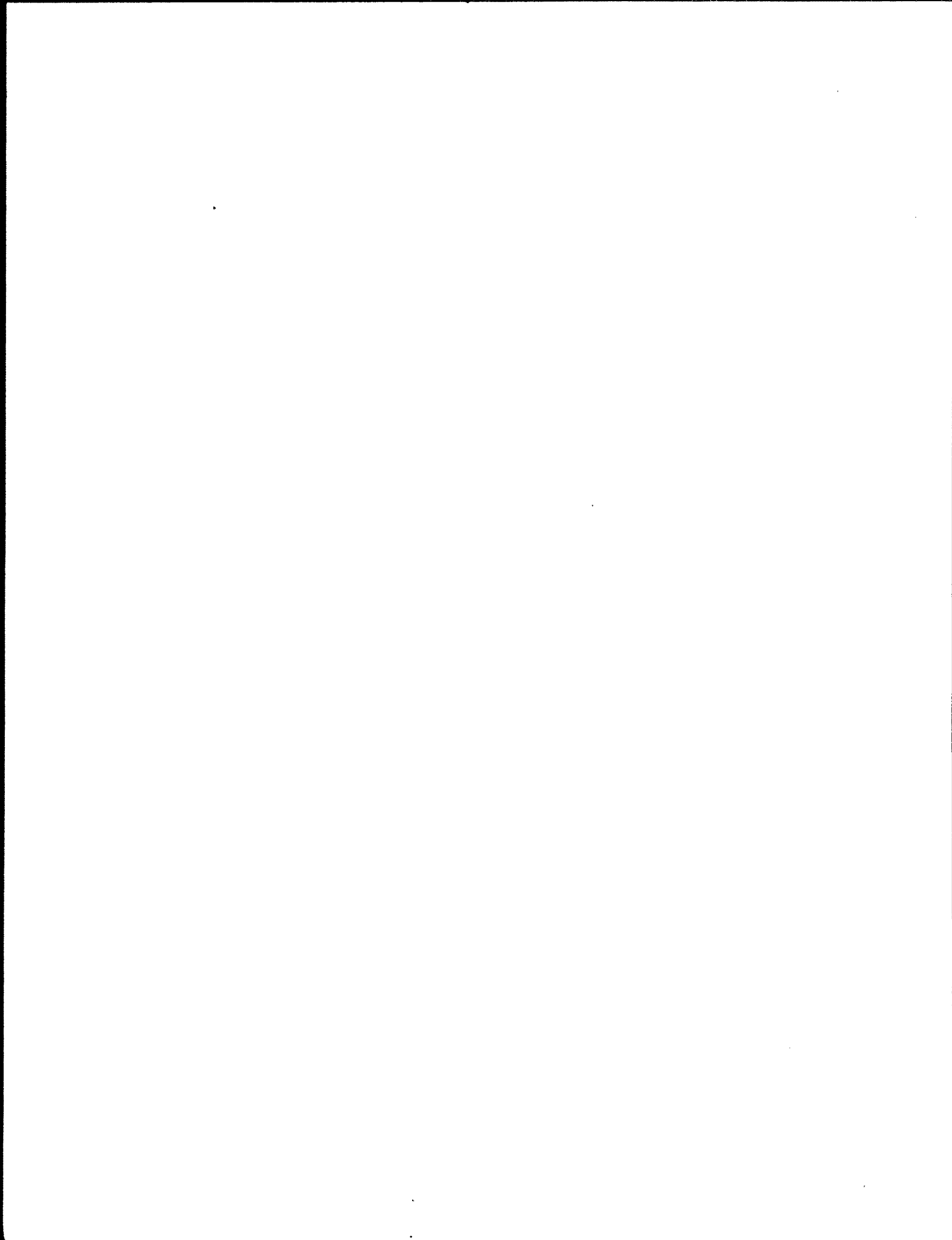


MONTREAL PROTOCOL
ON SUBSTANCES THAT DEplete
THE OZONE LAYER



**1994 Report of the
Economics Options Committee**

1995 Assessment



UNEP
1994 Report of the
Economics Options Committee

1995 Assessment

Montreal Protocol
On Substances that Deplete the Ozone Layer

UNEP
1994 Report of the
Economics Options Committee

1995 Assessment

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for the
1995 Assessment
of the



U N E P

**MONTREAL PROTOCOL
ON SUBSTANCES THAT DEplete
THE OZONE LAYER**

pursuant to
Article 6
of the Montreal Protocol;
Decision IV/13 (1993)
by the Parties to the Montreal Protocol

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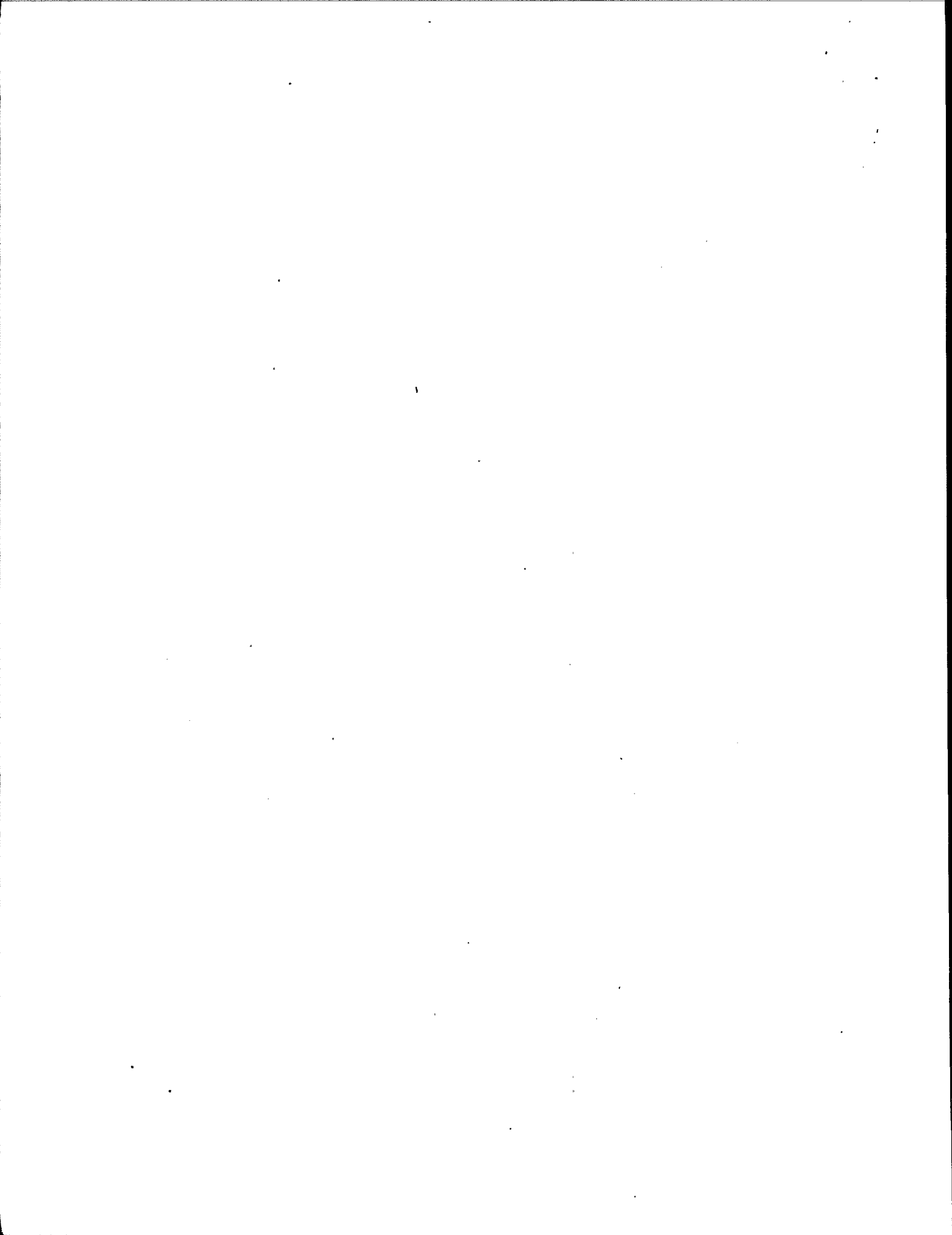
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The lead authors for each chapter were as follows: Professor Stephen J. DeCanio (Chapter 1); Dr Ahmed Amin Ibrahim and Mr Sergio Oxman (Chapter 2); Dr Anil Markandya and Mr Peter Landymore (Chapter 3); Dr David O'Connor (Chapter 4); Professor Penelope Canan (Chapter 5); Dr Anil Markandya (Chapter 6); Professor Stephen J. DeCanio and Associate Professor Jeffrey Williams (Chapter 7); and Dr Yusuf J. Ahmad (Chapter 8). The lead author for the Executive Summary and the Addendum was Dr Robert Van Slooten.

The Chair also acknowledges the comments and advice provided by those who participated in the Peer Review process. Their contributions were essential to the work of the Committee and were very much welcomed by Members.

Finally, the Chair acknowledges the contributions of the many individuals and organizations who facilitated the work of the 1994 Economic Options Committee.



Dr Robert Van Slooten
Chair,
UNEP Economic Options Committee

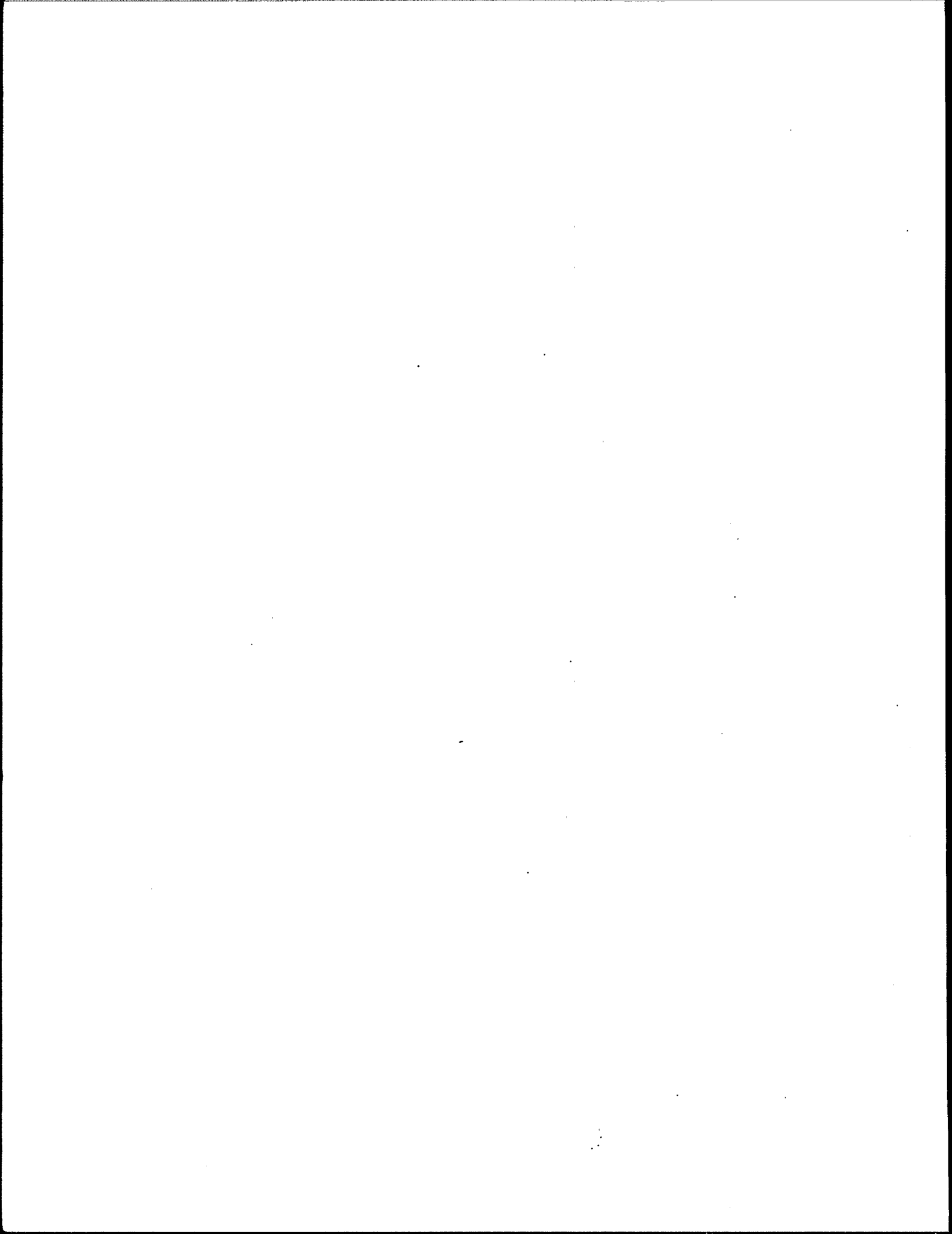


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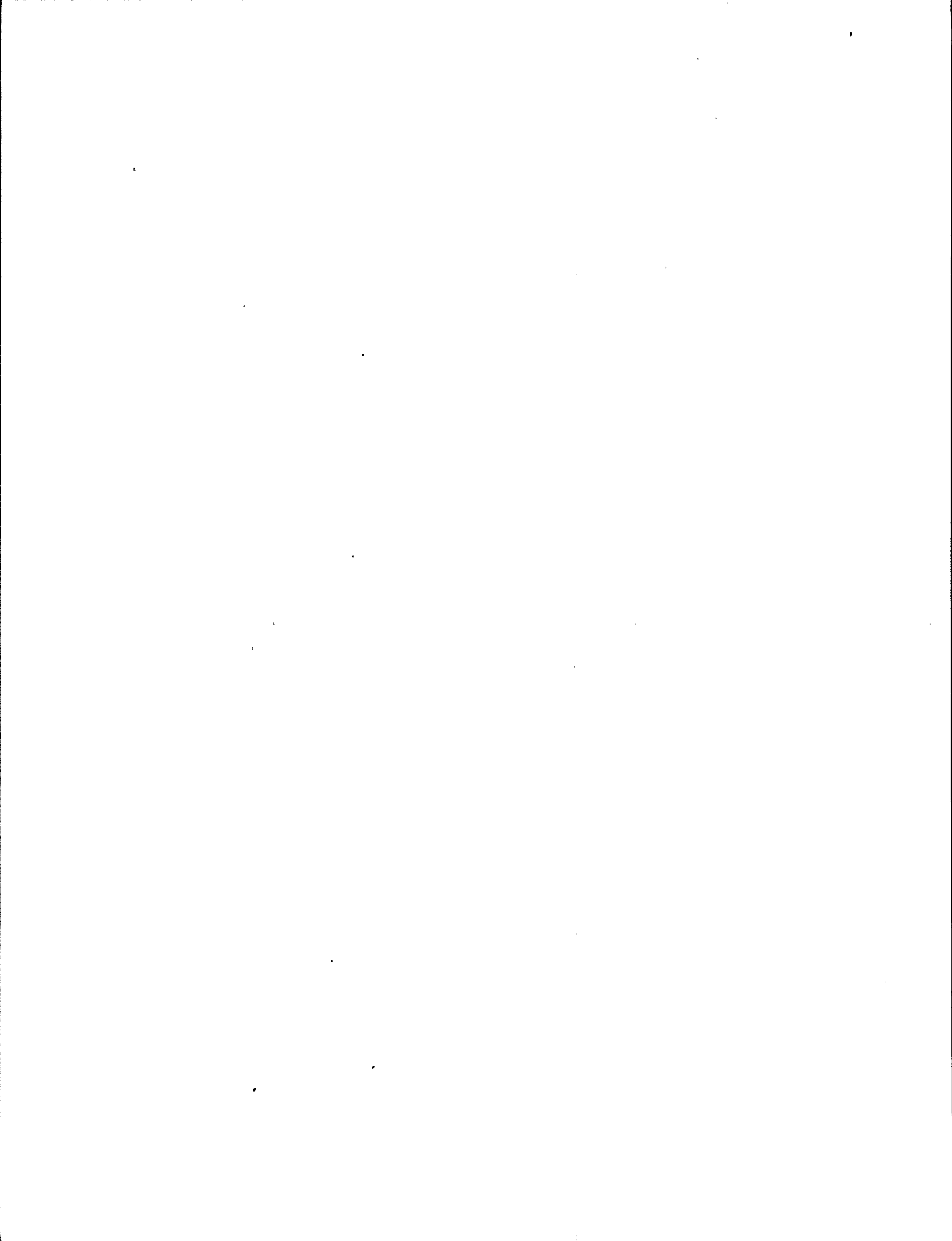
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1994 REPORT OF THE UNEP ECONOMIC OPTIONS COMMITTEE

EXECUTIVE SUMMARY

I INTRODUCTION

- ES.1 The EOC Report describes the transition from developed country ODS phaseout ("Phase 1") to concentration on progressing the developing country phaseout ("Phase 2") under the Montreal Protocol.
- ES.2 Phase 1 is defined in the EOC Report as that part of the implementation process through to the ODS phaseout in the developed countries at the end of 1995. The focus of Phase 1 has been on the urgency of protecting the ozone layer eg establishment of the Protocol; building consensus and institutions; promoting development of ODS alternatives and their use in developed countries. Phase 1 provided examples of the critical importance of individual leadership in securing "lift-off" for the Protocol process. Following the launch of the institutions of the Protocol, the varying adequacy of their performance and of the implementing agencies became increasingly apparent.
- ES.3 Phase 2, in broad terms, is defined as the ODS phaseout in the Article 5(1) countries as of the beginning of 1996 plus the continuing controls on HCFCs and methyl bromide in the developed countries. We are now in the early stages of the transition to Phase 2 with the approaching phaseout in the developed countries and evidence of a review and re-thinking of priorities, mechanisms and resourcing by developed countries. For example,
- some institutional initiatives need to work better;
 - the increasing prominence being given to compliance issues eg trade in newly produced ODS misrepresented as "recycled" material; and
 - the influence of new people and new perspectives on the evolution of the Protocol process.
- ES.4 The EOC Report develops the transition theme by (1) reminding the reader of the remarkable **achievements** recorded during Phase 1; (2) identifying and substantiating the scope for **improvements** in those institutions and processes that are essential to the successful implementation of the Montreal Protocol; (3) identifying and assessing the **key concerns** regarding the implementation process as it moves into Phase 2; (4) **addressing** some salient aspects of **these concerns**; and concludes with general and specific lessons of the Protocol process that might be **transferable** to the design of

other international environmental agreements.

- ES.5 This summary does not follow the chapter sequence of the Report ie each element of the transition theme draws on more than one chapter of the Report.

II. ACHIEVEMENTS

- ES.6 The achievements realized during Phase 1 have progressed more rapidly, and at lower economic cost, than had been expected at the signing of the Montreal Protocol. Economists have referred to the unexpected achievements of the Protocol given the initial resistance of powerful economic, corporate and regulatory forces to the technical and economic feasibility of its objectives. The ratifications of the Montreal Protocol (1990), the London Amendment (1992), and the Copenhagen Amendment (1994) were highly important and substantial achievements. Yet perhaps even more impressive has been the way scarce talents and resources have been mobilised to forge the progress that has been achieved in ODS reduction.
- ES.7 The EOC Report explores possible explanations for these surprising achievements of the Protocol during Phase 1. This is not a matter of speculative or historical interest; it conditions the EOC's interpretation of the major risks facing the Protocol during the transition to Phase 2.
- ES.8 The success of Phase 1 was not inevitable. The first step required that the stratospheric ozone-depletion problem be identified and credible. To do this, the scientific community had to document both the existence and anthropogenic sources of the problem as well as the seriousness of the potential effects. Second, industry and the research and development community had to be mobilised. Third, the international political and policy-making communities had to negotiate, design and implement the Montreal Protocol; and fourth, public and private enterprises had to implement the new technology. Without credible science neither the industrial nor the political communities could have been mobilised; nor could this have happened without the contribution of the policy-making community to the design of cost-effective policy regimes created the market incentives needed to mobilize industry's resources in support of ODS reduction. Whilst consumer responses to the use of ozone-depleting substances, especially in aerosols, provided an early market incentive to producers, industry's powerful contribution to the achievements of Phase 1 were firmly based on the market incentives provided by the regulatory regimes that were designed to implement the ODS phaseout schedules of the Montreal Protocol.
- ES.9 Companies developed a wide range of technologies ranging from non-ozone depleting chemical substitutes to not-in-kind methods (including product redesign) to replace ODS applications. In non-Article 5(1) countries, the need to phase out ODSs led to both technological and organizational innovation across the industrial spectrum. In some cases the new methods have been profitable in the narrow economic sense as well as being beneficial for the environment. Focused innovation and increased management attention have produced cost-saving and product-improving opportunities.

Case studies in the refrigeration and electronics sectors attest to the success of the conversions to non-ozone depleting methods.

- ES.10 Article 5(1) countries are also contributing to the phaseout. Ozone-friendly technologies are being developed and diffused in these countries through the transfer of equipment and expertise by multinational corporations, individual and joint national research programs, industry organizations (such as ICOLP, JICOP, and JEMA), and international government-industry partnerships. The Multilateral Fund, agreed at the London Meeting of the Parties in 1990, is playing an important role in facilitating the transfer of ozone-friendly technologies to Article 5(1) countries.
- ES.11 This record of achievement is largely the product of an informal network or "community" amongst a broad span of experts (eg industrialists, scientists, technologists, policy-makers, economists, NGOs) with a common interest in the objectives of the Montreal Protocol ie the "Protocol community".

III. IMPROVEMENTS ARE NECESSARY.

- ES.12 The achievements of Phase 1 have been impressive, but the "Protocol community" should not relax its efforts during the transition to Phase 2 - there remains much important work to be done. There are obstacles remaining. Some ODSs, such as the pesticide methyl bromide, are not as far along in the replacement process as the ODSs originally controlled under the Protocol. Although ODSs in some critical uses (such as solvents in electronics manufacture) have all but been eliminated, in other industries it is likely that the easier substitutions were undertaken first. Complete elimination of ODSs in all sectors will continue to challenge management, engineering, and production staffs.
- ES.13 A number of policy issues also remain to be resolved. These include: matching the global phaseout schedule of all significant ODSs to the most recent scientific and environmental assessments of the risks those substances pose to the ozone layer; ensuring the adequacy of the Multilateral Fund to fulfil its mandate of covering the incremental costs of the phaseout to Article 5(1) countries; appropriately regulating transitional chemicals such as HCFCs: intelligently managing the stock of already produced ODSs to minimize premature obsolescence of existing ODS-using equipment; and designing and implementing policies that will encourage innovation and productivity growth while meeting the environmental imperative to protect the ozone layer.
- ES.14 Whilst seeking to overcome obstacles and to resolve key policy issues, the "Protocol community" play important roles in bringing expertise to bear on recurrent efforts to weaken the critical underpinnings of the commitment to implement the Montreal Protocol eg (1) the science base; (2) the availability and cost of ODS alternatives; (3) the net benefits of the ODS phaseout; (4) the political commitment to the Article 5(1) countries; (5) the capacity to resolve operational shortcomings eg of non-compliance;

inadequate institutional performance; gaps in management controls; public confidence in and political commitment to the Protocol process. In practice, the capacity both to resolve real uncertainties and to provide the advice needed to discriminate between constructive criticism and "de-bunking" efforts lies within the "Protocol community".

IV. CONCERNS REGARDING CONTINUED PROGRESS.

- ES.15 The successful transition from Phase 1 to Phase 2 will require continuing support for the phaseout process in the Article 5(1) countries. Although some Article 5(1) countries have successfully accelerated their phaseout schedules, it is not possible for the Article 5(1) countries, as a whole, to take the full burden of responsibility for their own phaseouts. The preparation of the EOC Report exposed a widely-based concern over whether and to the extent to which the developed countries might reduce their commitments to the Article 5(1) countries during the transition to Phase 2.
- ES.16 The major concerns of the Article 5(1) countries brought to the attention of the EOC were as follows:
- whether political support to stratospheric ozone protection will be sufficient to sustain the transition to Phase 2 and the subsequent phase-out process;
 - the adequacy of political and financial support for the institutions of the Montreal Protocol; and
 - the extent to which a cooperative approach of industry to the transfer of technology to the Article 5(1) countries can be sustained.
- ES.17 Concern was also expressed over the potential for bilateral assistance to increase relative to multilateral assistance. Whilst bilateral assistance might bring quicker disbursement, concern over cost-effectiveness led to suggestions that bilateral projects should be subject to the same degree of scrutiny as that applied to multilateral projects.
- ES.18 The transition from Phase 1 to Phase 2 has revealed a perceived risk that supplies of ODS and ODS alternatives might not be adequate to meet market demand on terms acceptable to the Article 5(1) countries. The consequences could be unexpectedly large increases in ODS prices and higher than expected adjustment costs during the phase-out process.
- ES.19 Chapter 6 of the Report raises concerns regarding the compatibility of the Protocol with (1) the trade provisions of the GATT/WTO; and (2) the potential for trade restrictions to be imposed on recycled ODS either for reclaiming or redistribution under the Basel Convention on the Transboundary Movement of Hazardous Wastes and Their Disposal. It remains to be seen how the WTO Trade and Environment Committee will review the world trade implications of the Protocol's trade measures,

especially with respect to trade in products that are made with but not containing ODSs. The UNEP Ozone Secretariat and the Basel Convention Secretariat are keeping in close contact over these matters. So far, no specific cases of incompatibility between the Montreal Protocol and the Basel Convention have been reported.

V. ADDRESSING THE CONCERNS OF THE ARTICLE 5(1) COUNTRIES.

- ES.20** Success in responding to these concerns is likely to be variable. The capacity to manage them lies, largely, with the "Protocol community". This capacity cannot be sustained without adequate resourcing. Signals to the effect that the donor countries are re-thinking the extent of their resource commitments to the Protocol process as the transition from Phase 1 to Phase 2 progresses are raising concern over the future capacity of the "Protocol community" to help secure the success of Phase 2 of the implementation process.
- ES.21** Concerns over the supplies of ODSs and ODS alternatives during the transition to Phase 2 could be reduced by establishing broadly-based recovery, recycling and banking operations. The work of the EOC indicates that the economic incentives to recycle and reclaim CFCs, and to repair and retrofit CFC-using equipment, would strongly influence the amount of CFCs available to service existing equipment. The adequacy of the current stock of CFCs (including stockpiles and the material contained in functioning equipment) for future service needs will depend on leakage rates, retrofit rates, and recovery rates, which are all variables that are responsive to prices, as well as on the costs of cleaning, storing, and ensuring the quality of the recycled CFCs. With intelligent bank management, it should be possible to avoid shortages over the normal lifetimes of existing CFC-using equipment. The EOC Report describes specific government policies that could increase the effectiveness of recycling and banking operations.
- ES.22** The EOC's review of policy regimes for ODS phaseouts in Chapter 4 highlights the following key findings that could help Article 5(1) countries to increase the efficiency of their phaseout regimes:
- voluntary initiatives are more effective in generating publicity and momentum for ODS phaseouts where there is an aware public group or NGOs capable of monitoring progress;
 - most countries opt for some sort of quantitative restrictions (eg quotas) managed through import and, in some cases, production permit or licensing systems;
 - permit systems have been used as a relatively simple way of generating efficiency gains during the phaseout; and
 - excise taxes have been used to discourage ODS use, reduce "excess profits" generated by rising ODS prices due to regulatory controls, and

to raise revenue eg to help finance ODS phaseouts.

ES.23 The EOC took note of the concerns facing the information-exchange services of the Montreal Protocol institutions during the transition to Phase 2. The EOC takes the view that user demand for these services will continue at a high level. It noted that changing information needs and innovation in information systems will provide opportunities to improve performance. Responses should focus on building consensus regarding (1) the proper role of information exchange services, and (2) the capacity to identify and meet the evolution of user demand in a cost-effective manner. The view of the EOC is that information exchange is an essential element of the "package of inputs" required to achieve ODS reduction.

ES.24 The supply of information regarding ODSs and the global response to their phaseout is now overwhelming. The capacity to identify, organize, retrieve and use the most pertinent scientific and technical information is a key resource in the ODS phaseout process. The information exchange services provided under the Protocol are well-placed to meet the need for an up-to-date repository and locus for dissemination of the ever-expanding wealth of scientific, technological and organizational information pertinent to the phaseout process. There are three particular areas of information exchange that appear to be highly promising ie

- the community of relevant "experts" from industry, government and academia;
- local or regional networks of those involved in the implementation of the Protocol; and
- "smart" global communication networks enabling the linking of databases via eg INTERNET.

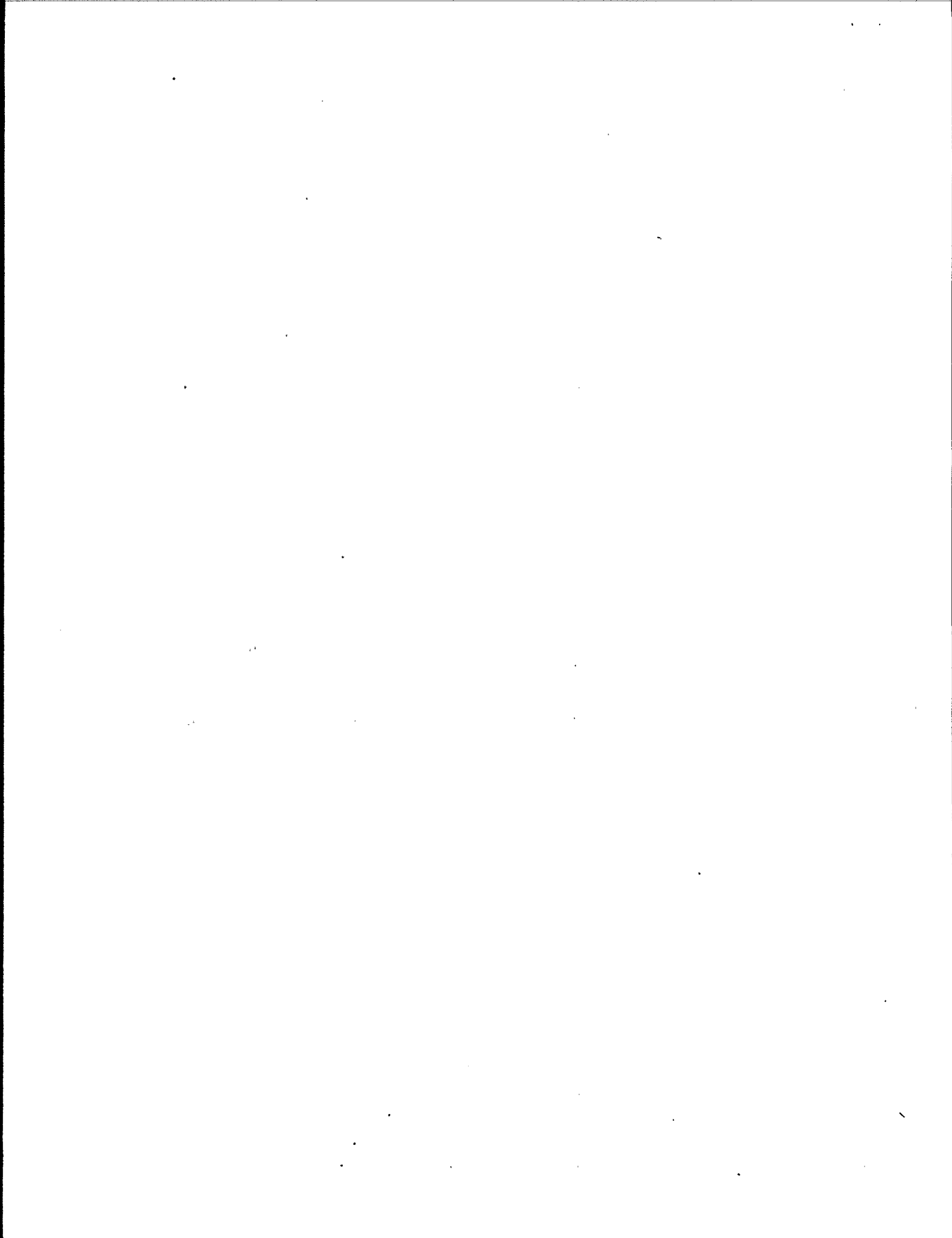
All of these areas are being addressed by the Ozone Action Information Clearinghouse. However, the performance of these programmes has been questioned sufficiently for EOC to suggest that a formal performance evaluation should be undertaken of all information exchange activities carried out by the institutions of the Montreal Protocol and their implementing agencies.

VI TRANSFERABILITY

ES.25 The EOC concluded its Report with an attempt to identify general and specific lessons that might be transferable to the design of other international environmental agreements (IEAs). It addresses the structural design features of the Protocol; performance within these structures is not addressed.

ES.26 The distinctive aspect of the Montreal Protocol is that it was the first IEA to strike a working balance between what is politically feasible, economically acceptable

and scientifically necessary. It is argued in Chapter 8 that many of the elements of the Montreal Protocol process might usefully be incorporated in the design of new IEAs. Even so, the selection of the specific elements to transfer must be evaluated with respect to the experience already gained and also have regard to the specific characteristics, needs and constraints of the new IEAs in the making. In this way, steady progress can be made up the "learning curve" that applies to the design of IEAs and hence to more efficient instruments for managing risks to the global environment.



CHAPTER 1

THE DYNAMICS OF THE PHASEOUT PROCESS UNDER THE MONTREAL PROTOCOL

I. INTRODUCTION.

The international effort to protect the earth's ozone layer has entered a new phase. The Montreal Protocol on Substances that Deplete the Ozone Layer, originally signed in 1987, has twice been amended or adjusted (London 1990 and Copenhagen 1992). Most of the countries of the world, including all the major producers and consumers of ozone depleting substances (ODSs), have indicated their commitment to the ODS phaseout process through the operation of the Protocol. The most significant of the ODSs are now listed as controlled substances under the Protocol and all, with the exception of methyl bromide, are scheduled for phaseout. Production of the most widely used CFCs will be terminated in the non-Article 5(1) countries¹ by 1 January 1996, except for a few "essential use" exemptions. Production of Halons in these countries ceased as of 1 January 1994. Consumption of HCFCs is scheduled to be phased out steadily, reaching zero by 1 January 2030 (United Nations Environment Programme (UNEP) 1993a). A number of countries, including the European Union and the United States, have adopted even more rapid phaseout schedules for some of the controlled substances than is specified in the revised Protocol (Kruse 1994; MacKenzie 1992; *Global Environmental Change Report* 1994c).

The original Protocol provided for periodic review of the regulatory schedule as new scientific information was developed. Both major revisions of the Protocol have increased the stringency of the international regulatory regime. Additional ODSs have been added to the list of controlled substances, and the target moved first from a 50% reduction (as specified in the original Protocol) to a complete phaseout (London). The phaseout date was moved forward at Copenhagen in 1992. The regulatory schedule and coverage have been tightened over time because of continuing accumulation of evidence regarding the extent and adverse effects of ozone depletion.

The current state of scientific knowledge concerning the physical and chemical processes of stratospheric ozone depletion is presented in the *Scientific Assessment of Ozone Depletion: 1994* (UNEP et al. 1994). The findings of the international scientific panel that prepared this report include, *inter alia*: record low global ozone levels were measured over the last two years (although the downward trend was exacerbated somewhat by the eruption of Mt. Pinatubo in

1. Article 5(1) countries are broadly classified as "developing" but more accurately they are those with annual per capita consumption of ODSs of less than 0.3 kilograms at the date of entry into force or at any time thereafter, until 1 January 1999. Countries not operating under Article 5(1) will be referred to as "non-Article 5(1) countries" throughout.

1991); downward trends in total-column ozone continue to be observed over much of the globe, but their magnitudes are underestimated by numerical models; the conclusion that anthropogenic chlorine and bromine compounds (coupled with surface chemistry on natural polar stratospheric particles) are the cause of polar ozone depletion has been further strengthened; the Antarctic ozone holes of 1992 and 1993 were the most severe on record; the link between a decrease in stratospheric ozone and an increase in surface ultraviolet (UV) radiation has been further strengthened; and methyl bromide continues to be viewed as a significant ozone-depleting compound.

Scientific understanding of the range and severity of the effects of stratospheric ozone depletion is reviewed and summarized in *Environmental Effects of Ozone Depletion: 1994 Assessment* (UNEP 1994b). This assessment confirms earlier findings that ozone depletion has adverse effects on human and animal health (including morbidity and/or mortality from eye diseases, skin cancer, and infectious diseases), terrestrial plant productivity, aquatic ecosystems, air quality, and materials.²

Ozone depletion also interacts with global climate change and biogeochemical cycles. The direct global warming effect of CFCs and other anthropogenic greenhouse gases is partly offset by the CFC-induced destruction of the stratospheric ozone (UNEP 1991a; Stratospheric Ozone Review Group 1993; UNEP et al. 1994). However, the negative effect of increased UV-B coming through the Antarctic ozone hole on the growth of phytoplankton in the southern oceans may increase the rate of global warming, because the phytoplankton are a major carbon sink (UNEP 1992a; Committee for the National Institute for the Environment 1992; UNEP 1994b).³

The Parties to the Montreal Protocol have established a variety of internal regulatory mechanisms to accomplish the objectives of the Protocol. In addition, international institutions, such as the Ozone Secretariat, the Multilateral Fund, and the UNEP Industry and Environment Programme Activity Centre (UNEP IE/PAC), are working to achieve the Protocol's goals. These efforts have been matched by the contributions of private sector business firms, academic researchers, and non-governmental organizations (NGOs). The seriousness of the danger has made it all the more important that actions to protect the ozone be carried out as efficiently as possible, and that all the lessons that have been learned from the world's experience to date be assimilated and internalized.

2. Other negative effects of ozone depletion have been suggested by recent research. One study found that for small ozone losses (less than 5%), the biological damage caused by associated increases in UV-B radiation increases linearly with the amount of depletion, but that the biological consequences increase non-linearly at greater ozone loss levels such as those already experienced in the Antarctic ozone hole (Lloyd 1993). Heightened ultraviolet radiation caused by thinning of the ozone layer has been implicated as a possible contributory factor in the previously unexplained decline of frog and toad populations worldwide (Yoon 1994; Blaustein et al. 1994; see also Yoffe 1992).

3. The emissions causing global warming may also indirectly damage the ozone layer. Increased atmospheric carbon dioxide concentrations are expected to cause a cooling of the lower stratosphere, creating in the Arctic region the preconditions for formation of the polar stratospheric clouds that play a key role in causing the Antarctic ozone hole. Thus, carbon dioxide and other greenhouse gas emissions could lead to further ozone depletion over the northern hemisphere (Austin et al. 1992; Abbatt and Molina 1993).

II. RECENT ODS REPLACEMENT EXPERIENCE.

A. Absence of Insurmountable Technical Bottlenecks.

The conclusions of the 1991 *Report of the Economic Options Committee* (UNEP 1991b) have been confirmed by developments since that *Report* was written. ODS replacement has been more rapid, less expensive, and more innovative than had been anticipated at the beginning of the substitution process. The alternative technologies already adopted have been effective and inexpensive enough that consumers have not yet felt any noticeable impact (except for an increase in automobile air conditioning service costs) from the more than 50% reduction in CFC use in the non-Article 5(1) countries that has already been accomplished.

At the Copenhagen meeting of the Parties in 1992, a procedure was adopted that would enable Protocol signatories to nominate "essential use exemptions" for CFCs or Halons. Such exemptions, for specific uses over limited time periods, would authorize small amounts of production to continue after the phaseout deadlines for these compounds. Halon production was phased out on 1 January 1994, so the first round of exemption applications covered Halon production only. Although a number of users in various signatory countries applied for exemptions, none of the applications referred to the Technical and Economic Assessment Panel (TEAP) were recommended to the Parties, and the one application submitted to the Parties was eventually withdrawn (UNEP 1993). Plans for judicious use of the existing stock of Halons contributed to the Parties' decision (See Chapter 7 below). Even if applications for exemptions are submitted in the future, the denial or withdrawal of essential use nominations for Halons in 1994 is strong evidence that, given rational Halon bank management, continued production of these compounds for critical applications is not needed. The military in Russia, Sweden, the United Kingdom, and the United States did not request exemptions, nor did the United States National Aeronautics and Space Administration. No manufacturer of civilian or military aircraft requested an exemption (UNEP 1993b).

The 1994 Technical and Economic Assessment Panel (TEAP) has recommended only three essential use exemptions to allow CFC production in non-Article 5(1) countries after 1 January 1996: aerosol metered dose inhalers, specific cleaning, bonding, and surface activation procedures for the NASA Space Shuttle's solid rocket motor; and global laboratory/analytical uses. Although some other uses were nominated, including aircraft maintenance, foam standard-of-reference, fire fighting, furniture adhesives, membrane manufacturing, navigation and guidance devices, topical anesthetics, and uranium enrichment, none of these exemptions was recommended by the TEAP. Nor were exemptions granted for servicing of refrigeration and air conditioning equipment. Even in the case of metered dose inhalers, the TEAP recommended a major push by governments, medical associations, and industry to educate doctors and patients about alternatives, and programs to recapture and destroy the CFCs in inhalers whose shelf-life has expired or that will be replaced by substitute delivery systems (*Global Environmental Change Report* 1994d).

Of course, in some applications the substitutes may be more expensive than the ODS technologies they replace. It is likely that the least costly substitution opportunities have been among the first ones taken. There remain design problems to be overcome and choices to be made where alternative substitution approaches are feasible. Technology transfer to Article 5(1) countries must be completed in a cost-effective manner that does not hold back their development progress. Nevertheless, it is clear that enormous advances have been made in the effort to find ODS alternatives. Phaseout measures have begun to have a measurable impact on CFC concentrations in the atmosphere (UNEP et al. 1994; Elkins et al. 1993), and many countries and companies are eliminating ODSs faster than the schedule specified in the amended Protocol. It will also be clear from the discussion and examples presented below that many of the replacements are superior to the ozone depleting technologies they supersede, even in the narrow sense of being economically profitable without taking account of the monetary and environmental benefits of ozone layer preservation.

B. Recent Experience in Non-Article 5(1) Countries.

Industrial response to the challenge of ODS replacement in the non-Article 5(1) countries continues to gain momentum. Companies and governments are still beating the regulatory deadlines for phaseout. By May 1993, over 60 manufacturers from Canada, Germany, Japan, Sweden, and the United States had ended the use of CFC-113 in their global operations (*OzonAction* 1993a). Particular examples of successful changeover from ozone-depleting technologies are now too numerous to mention individually, and any partial listing would risk doing an injustice to the multitude of other enterprises large and small that have made or are making the transition away from ODSs.

Therefore, rather than merely highlighting a few selected examples of successful changeovers, this *Report* will take a different approach. Enough experience has been accumulated to begin to allow tentative generalizations about the underlying dynamics of ODS replacement. Development of an overview of the substitution process can provide valuable information both to the Parties and to business firms. In many cases, the organizational adaptations and innovations associated with ODS replacement are as interesting and important as the specific technological innovations.

1. Lessons from the Refrigeration Industry.

Refrigeration is the application for which CFCs originally were invented (Cagin and Dray 1993). This large and important sector faces difficult obstacles in finding substances and/or technologies to replace CFCs. According to one estimate, 112,000 industrial chillers and 2,000,000 commercial refrigeration units are installed globally (Vogelsberg 1993, citing UNEP 1991c). To these must be added the tens of millions of domestic refrigerators in use throughout the world. As recently as 1992, the appliance industry in the United States feared it would be in deep trouble without an exemption from the CFC ban. Yet the industry now "believes it has solved some thorny conversion problems" (Zurer 1992, 1993b).

In mobile air conditioning, it is now apparent that HFC-134a will be the replacement technology of choice. Five major automobile manufacturers converted from CFC-12 to HFC-134a systems in 1993; most automobile manufacturers will have made the shift worldwide by the beginning of 1995 (UNEP 1993b). Servicing and/or retrofitting the existing automobile fleet remains a problem, but some CFC stockpiles are being held for this purpose. Work also continues on retrofit technologies. Fleet field trials have shown promising results. ICI Australia reported similar levels of consumer satisfaction with retrofitted 134a systems as with CFC-12 systems (Dekleva et al. 1993), and two small fleet tests of retrofitted systems in the United States conducted by Elf Atochem N.A., Inc. found that drivers felt no noticeable difference between their "old" and "new" systems (Rolotti and Leonard 1994). A recent review of retrofit trials around the world concluded that "HFC-134a retrofits seem to be less complicated and less costly than once thought" (Colmery and Lindley 1994).

The U.S. Environmental Protection Agency has compiled a set of ten case studies of firms that have completed or are in the process of completing the changeover of their refrigeration applications. These firms used CFCs in comfort coolers, industrial processes, and commercial refrigeration. The companies profiled were engaged both in retrofitting and the installation of new refrigeration systems. For the companies carrying out retrofits, the most common experience was that capacity and energy efficiency losses were either negative (i.e., systems performance improved) or smaller than anticipated. Even in the cases where there was no gain (or a loss) in energy efficiency, productivity gains could be realized through a combination of tightening the equipment to reduce leakage and implementation of inventory systems to keep track of refrigerant. As one company spokesperson put it, "monitoring and reducing refrigerant consumption is not only sound environmental practice, it makes economic sense."

One reason firms initiated their retrofit programs was their desire to avoid future interruptions in service as CFC supplies become scarce. In addition, even the immediate cost and disruptions associated with the retrofits have been smaller than originally imagined. Companies have found that their own ability to manage the conversions (as well as the capability of outside contractors when they have been used) has improved as experience accumulates. The CFCs recovered through conversions can either be held for servicing unconverted equipment or sold to a reclaimer to help defray retrofit costs.

In cases involving the purchase of new equipment, additional opportunities for profitable investment are available. It is possible to buy new equipment flexible enough to accommodate the eventual phaseout of HCFCs. Replacement of CFC-using machinery with new equipment offers the chance to modernize maintenance and institute remote monitoring (e.g., via modem) to reduce costs. New equipment can be of more energy-efficient design.

Successful conversion operations tend to be ones that have a designated team and a team leader with responsibility, a budget, and accountability. The best strategy appears to be to proceed on an empirical basis, with test conversions preceding company-wide conversion. Taking a hard look at managing the transition away from CFCs provides a chance to revamp management and control methods. As one food chain executive said, "the CFC issue is really

making supermarkets manage in a whole new way, and that's not necessarily bad" (U.S. EPA 1993a).

2. Lessons from the Electronics Industry.

Use of CFC solvents in the electronics industry has been a critical application. Manufacture of electronic components is complicated and difficult, and these assemblies are used in some of the most demanding environments imaginable, including military hardware. Tough military specifications reflect the high levels of quality and reliability required of these components. CFCs and related compounds were long thought to be ideal solvents because they are so nonreactive. Nevertheless, the electronics industry has pioneered both technologies and organizational models for replacement of CFCs. In a number of instances, the substitute technologies have saved money and improved quality over the CFC technologies they replaced.

A number of major electronics companies have reported competitive advantages deriving from their elimination of CFCs. Examples are widespread. "In December 1991, Northern Telecom became the first multi-national company to completely halt the use of CFC solvents....Many companies with successful ODS phase out programs developed new cleaning methods, or eliminated the need to clean altogether, while maintaining their competitive edge. Electronics companies report cost savings, simplified manufacturing, and higher reliability by switching to new technologies. For example, Ford, Honeywell, Hughes, Motorola, and Texas Instruments are now manufacturing printed circuit boards that are cleaner than boards produced with CFCs, and meet the most demanding military specifications" (Andersen and Zoi 1993). Semi-aqueous solvents, currently accepted "across the board for Mil-Spec applications," exhibit "cleaning levels consistently higher than previously achieved with CFC-based solvents" (Amoukhteh 1993).

One of the techniques being implemented is "no-clean soldering," which offers obvious cost advantages over soldering processes requiring cleaning. No-clean soldering "costs less than most other processes....[and] eliminates the costs and environmental impacts associated with the manufacture, use, maintenance, and disposal of cleaning equipment....The potential savings in energy and waste from using the no-clean process is significant" (Iman and Lichtenberg 1993). A recent study of PCB corrosion has shown that "the reliability of CFC-cleaned PCBs and no-clean PCBs are similar....[T]he no-clean process displayed no significant reliability differences compared with the CFC-cleaned board" (Amoukhteh 1993).

IBM, after surveying the manufacturing locations that were responsible for about half of the company's use of CFC-113, devised a strategy in which the phaseout "was framed as a design problem for process and development engineers that would require innovation and invention for success." The IBM San Jose operation had the highest industrial emissions of CFCs in the United States in 1987 (1.5 million pounds). Yet this facility was able to eliminate CFCs entirely by 1993, moving to aqueous cleaning and high temperature drying. The San Jose experience became a model for other IBM facilities. According to company assessment, "while the overall dollar value is difficult to assess, many of the projects have been highly cost effective....[T]he

break-even point for site-wide CFC replacement occurred in the third quarter of 1991....[T]he site will save a potential \$3 million annually by eliminating CFCs" (Pruett et al. 1993).

Researchers around the world continue to push out the frontier of possibilities for replacing CFCs in solvent applications. A recent article by Lu and Aoyagi (1994), while conservative in avoiding claims that these new technologies are economically comparable to CFC cleaning, lists multiple references in the technical and scientific literature to aqueous cleaning, CO₂ snow (micro particle) cleaning, plasma cleaning, UV ozone cleaning, thermal cleaning in high vacuum, chemical gas cleaning, ion cleaning, UV light cleaning, electrolytic cleaning, electrostatic cleaning, and even surface cleaning by synchrotron light source, in addition to their own work on laser-induced dry cleaning in air.

The experience of the electronics industry demonstrates that phasing out of ODSs can be profitable and technologically progressive. While not all CFC replacement investments have been cost-saving, the creativity shown by this industry as the CFC phaseout date approaches is encouraging. The electronics industry has pioneered the development of institutions for sharing information on ODS replacement, such as the Industry Cooperative for Ozone Layer Protection (ICOLP). Its effort in finding substitutes for ozone depleting substances represents one facet of the industry's worldwide leadership in innovation.

C. Experiences of the Article 5(1) Countries.

Progress continues to be made by Article 5(1) countries in phasing out CFC use. There is, however, some cause for concern because of the expansion of CFC consumption in some rapidly-growing developing countries. According to the Ozone Secretariat, based on data available as of 9 May 1994, consumption of CFCs in 16 Article 5(1) Parties for 1992 had increased 45% since 1986. Consumption of other fully halogenated CFCs, methyl chloroform, and carbon tetrachloride was also up, but consumption of Halons had fallen by 18% (*OzonAction* 1994). It should be noted that this estimate is based on incomplete information, because reporting of data on ODS production, consumption, and trade is a problem that has resisted a quick or easy solution, in part because of the strains already placed on the customs and statistical services of Article 5(1) countries. (Data reporting continues to be a problem for some non-Article 5(1) countries as well.) With country programs now being required by the Multilateral Fund, data reporting will improve because data is required as part of the country programs. It may also be that some of the apparent increase in Article 5(1) countries' consumption is merely a statistical artifact, because some uses of CFCs were not included in countries' original inventories and as data collection has improved these previously uncounted uses have been measured. Some developing countries may also be increasing the amounts of CFC stored in anticipation of future shortages, and such an accumulation of stocks would be distinct from an increase in the rate of consumption.

A number of companies in Article 5(1) countries are acting on their own initiative to phase out ODSs, without assistance from the Multilateral Fund or any other source. Egyptian firms have replaced CFCs in aerosol applications. Manufacturers of flexible foams in Ghana and Brazil have phased out ODSs entirely. The Republic of Korea's Samsung Electronics has

become one of the world's first producers of a CFC-free refrigerator. Samsung's refrigerator has a high-efficiency compressor that boosts overall energy efficiency. "[D]uty came foremost in Samsung Electronics' motivations. [According to a Samsung spokesperson], 'The most important reason is that Samsung recognized that its products were destroying the ozone layer, which harms the health of the Korean people'....Another key factor was the world trend toward the environmentally-conscious manufacture of products. Finally, Samsung saw an opportunity to improve its competitiveness by being one of the most advanced initial producers of CFC-free products" (Chai 1993).

Both China and India have active research programs to develop and commercialize ODS substitute technologies. In India, the six major refrigerator makers are redesigning their products to use CFC alternatives and increase energy efficiency at the same time. The project is being advanced through the efforts of the Tata Energy Research Institute (TERI) and the U.S.-based International Institute for Energy Conservation (IIEC). Three refrigerator manufacturers (Godrej, Voltas, and Kelvinator), with the participation of the German refrigerator maker Foron, have begun a project with the Indian Institute of Technology and the National Chemicals Laboratory to develop hydrocarbon refrigerators. In China, the U.S.-Sino Refrigerator Project, a joint effort between the U.S. Environmental Protection Agency, the Chinese National Environmental Protection Agency, and the Chinese National Council of Light Industry, is developing a non-CFC refrigerator. Production is scheduled to begin in late 1995 or early 1996, and the new refrigerator is expected to be over 50% more energy-efficient than the standard Chinese model, in addition to having zero ozone depletion potential (*Global Environmental Change Report* 1994b, 1994e).

Multinational corporations operating in Article 5(1) countries have been an important channel for technology transfer to facilitate the ODS phaseout. The globalization of production has the effect of shifting production activities to areas outside of traditional locales, and with the shift of production has come the diffusion of ODS-free techniques. The technology transfer across a multinational corporation's different operating units is one of the chief ways capital, expertise, and operating procedures can move past national boundaries. In some cases, the transfer has received the institutional support of governments (as in the trilateral agreement between Thailand, Japan MITI, and the U.S. EPA, or the case of the cooperation between the Government of Mexico, the U.S. EPA, and Northern Telecom).

Industry organizations such as ICOLP, JICOP, and JEMA have been influential in securing a proactive response by multinationals operating joint ventures in developing countries. ICOLP has begun a Technology Cooperation Project to work in partnership with Article 5(1) countries in switching away from CFCs and other ozone depleters. Individual ICOLP members will be teamed with each participating country to serve as technical advisors. The U.S. Environmental Protection Agency and Japan's Ministry of International Trade and Industry will also be involved. One example of this type of project is Motorola's cooperation with Malaysian electronics and metal-cleaning companies to implement the latest aqueous and "no-clean" techniques to eliminate ozone-depleting solvents. ICOLP members will share their technology and the time and talent of their experts, while travel and lodging expenses are underwritten by the World Bank (*Environment Today* 1993a, 1993b). (See also Chapter 5 below.)

The Multilateral Fund is a complementary source of financial support for Article 5(1) countries striving to eliminate ODSs. The Fund has been distributing grants since 1991, and as of July, 1994, has more than 600 projects totaling about \$210 million in 73 countries. These projects range from small grants in the \$25,000 to \$60,000 range for country program preparation, to large projects of over \$4,000,000 to convert production lines to ODS-free technologies (Multilateral Fund 1994). At the 5th Meeting of the Parties, held in Bangkok in November 1993, the budget of the Fund was increased to \$510 million over the next three years (1994-1996), more than double the budget for the previous three years (*OzonAction* 1993b). As the Fund is augmented, its contribution to the ultimate elimination of ODSs will become even more notable.

A continuing challenge to the Multilateral Fund is to increase the speed with which its resources are deployed, without sacrificing project quality. Developing countries face substantial transactions costs in eliminating ODSs---there is a need for educating industry and the public to the seriousness of the ozone depletion problem, and difficulty identifying the enterprises (which are often very small) that use ODSs. Engineering staffs are stretched thin, and funds for investment tight. Once the effort has been made successfully to bring an ODS user to the point of contemplating a changeover, it is essential that funding be available with a minimum of red tape. The effectiveness of the Multilateral Fund in assisting developing country phaseouts depends on its ability to reduce the transactions costs, not add to them.

The Multilateral Fund should continue to be able to fund research related to refinements needed for the adaptation of existing technologies to developing country circumstances. This is particularly important, as such refinements are often needed to optimize new technologies that are being transplanted into new environments. However, given the limited resources available to the Multilateral Fund to achieve ODS reductions, it may not prove cost effective to divert resources to such areas as bench research on new alternatives, as this type of research is likely to be costly, duplicative of ongoing private sector efforts in other countries, and have little near term impact on ODS reductions.

A strong motivation for developing countries' governments and enterprises to phase out ODSs is their desire to produce exports that can be sold in developed countries. Globalization of markets provides great opportunities for developing country manufacturers. The rapid economic growth many developing countries have experienced recently, especially around the Pacific Rim, is due in large measure to the ability of these economies to sell to consumers around the world. In the case of products previously dependent on ODSs (such as refrigeration and air conditioning equipment, vehicles, and electronics), continuation of this export success will require elimination of ODSs on a schedule equivalent to that being followed in the non-Article 5(1) countries. Already, the United States has labeling requirements that have stimulated ODS replacement in Mexico, Thailand, and Turkey (UNEP 1994a).

D. The Case of Methyl Bromide.

Methyl bromide is used by field crop growers as a soil fumigant to control nematodes, root rot, weed seeds, and various micro-pests that depress yields, and as a pesticide for

commodity shipments and structures. This chemical accounts for between one-twentieth and one-tenth of currently observed global ozone depletion, a fraction that could rise to as much as one-sixth of predicted ozone loss by the year 2000 if methyl bromide emissions were to grow at historical rates (UNEP 1992b). In addition to its ozone-depleting potential, it has been identified as an acute toxin and has been implicated in pesticide poisoning of workers (Grobe and Buchanan 1993).

Beginning 1 January 1995, methyl bromide will be controlled under the Montreal Protocol to a level of production and consumption not to exceed 1991 levels. (For Article 5(1) countries, production may exceed the 1991 level by no more than 10%.) (UNEP 1993a, p. 12). The United States will freeze methyl bromide production and consumption at 1991 levels beginning in 1994, and will phase out methyl bromide completely as of 1 January 2001 (U.S. EPA 1993b).

The situation with respect to replacement of methyl bromide is analogous to conditions that prevailed in the early stages of the process of replacing other ODSs. Some users and producers of methyl bromide can now see no way the chemical can be replaced without causing serious damage to their operations. Industry representatives question the scientific basis of the concern that methyl bromide applied to the soil has an effect on the atmosphere and ozone layer. Countries with significant agricultural exports that are currently treated with methyl bromide are particularly sensitive (Zurer 1993a).

At the same time, a number of alternatives to chemical pesticides are already in use, or are under development. For stored food products, these include biological controls, pheromones, insect growth regulators, regulation of temperature, microbial controls, and trapping techniques. As in the case of CFC and Halon replacement, the widespread use of some of these alternative technologies has been hampered by cumbersome and inflexible regulation. For example, the U.S. Food and Drug Administration appears in some cases to apply more stringent standards to "contamination" of grain shipments by beneficial insect pest predators than it does to the pests themselves. The present registration process "is hampering the development of many less-toxic pesticides such as microbial insecticides, pheromones...and botanicals" (Olkowski 1988, 1989). The United States Department of Agriculture "requires...that citrus fruit from Mexico and grapes, apricots, peaches, nectarines, and avocados from Chile be fumigated [with methyl bromide] before they enter the U.S." (Zurer 1993a). Regulations specifying a performance standard, rather than requiring particular procedures (such as methyl bromide fumigation), would ease the transition away from methyl bromide. Analogous is how the change in military specifications from mandating CFC solvents in electronics manufacture to a performance standard has helped electronics makers reduce their dependence on CFCs (Certo 1992, 1993).

In soil treatment applications, researchers have shown that "active soil microbes can help control root pathogens, and organic matter inputs supply nutrients, energy, and physical habitat for microbes." As one strawberry grower put it, "methyl bromide has been a 'silver bullet' [i.e., an effective weapon against specific pests] for field crop growers, and as it is phased out, farmers will transition to more sustainable methods of soil management, based on controlling soil pests by encouraging establishment of beneficial organisms" (Grobe and Buchanan 1993).

It is likely that the views and practices of the methyl bromide users will evolve in a manner similar to those of other ODS users. Once the industry accepts that methyl bromide does in fact pose a threat to the ozone layer, opposition to its phaseout will diminish. The executive secretary of the North American Strawberry Growers Association has stated, "evaporation [of methyl bromide] from the oceans is a greater source [than agricultural use]. But if it is proven that methyl bromide is harmful, then we would not want to use it" (Zurer 1993a). Interim measures for controlling emissions, such as better housekeeping, will be available for the short run, while the search for, screening, and adoption of substitute technologies proceeds. International experience and technology transfer will speed the process. Agriculturalists and researchers in Australia, Mexico, The Netherlands, and Nigeria are among those already gaining experience in relying on biologically complex, healthy soils rather than methyl bromide or soil fumigation to control pests (O'Brien 1992). Alternative fumigation procedures are also promising (Mueller 1994).

It is possible that some of the innovation prompted by the regulation of methyl bromide will yield processes that are cheaper and better on narrow economic grounds, just as has been the case for many ODS solvent and aerosol applications. Even if the best alternative technologies are more expensive than methyl bromide, Article 5(1) country users will be eligible for assistance from the Multilateral Fund to meet the incremental cost of replacement.

III. EXPLANATORY FRAMEWORK.

A. ODS Replacement Can Have Multiple Benefits.

Economic theory and management science have been challenged to predict or even understand the breakthroughs in ODS replacement that have already taken place. Most conventional discussions of the impact of environmental regulations on productivity and economic activity hold that the regulatory impact is, except for the benefits realized through control of adverse environmental externalities, negative (Gray and Shadbegian 1993; Simpson and Bradford 1993). On the other hand, there is a growing recognition in the literature that pursuit of environmental protection goals can produce collateral benefits in productivity, innovation, and competitiveness (Moore and Miller 1994; Porter 1991). To those actually involved in the ODS phaseout process it is apparent that significant productivity and product quality advantages frequently have accompanied the adoption of ozone-friendly technologies. Partly this is the result simply of putting new equipment and methods in place. Any new technology would have represented an improvement over the old, regardless of why the innovation was adopted. Environmental regulation is only one of many stimuli for change.

It is notoriously difficult to evaluate the exact profitability of a new investment. Whole firms or operating units can be observed to generate positive or negative cash flows, but when changes are made within an organization, it is often not easy to quantify the costs and benefits associated with the change. Innumerable factors that impinge on the overall performance of the organization may be affected in complex ways by a change, and influences external to the

organization may affect performance for reasons unrelated to the change. Elimination of ODSs is mandated under law, so that conventional profitability criteria are not decisive in the decision to go ahead with the investments.

Nevertheless, there is evidence that ODS replacement may be one of those instances in which environmental regulatory pressure can have a positive net impact on organizational performance. This possibility was discussed in the 1991 *Report of the Economic Options Committee*, and the evidence that has accumulated since that time has not contradicted that assessment. Companies continue to report that the installation of new, ozone-friendly technologies has improved quality and productivity, and that these investments "pay for themselves" (UNEP 1991b and references cited therein; U.S. EPA 1993a; Kenward 1992).

It would be no simple matter to quantify the positive effects on morale, employee motivation, and the firm's public image of the ODS replacement effort, or to weigh these factors against the possible diversion of capital and managerial attention from other investment opportunities. Regulatory pressure to eliminate ODSs can have the effect of inducing management to re-engineer outmoded practices; it may also create additional burdens for management already struggling with the tasks of downsizing or the imperatives of global competition. It is difficult or impossible to know the returns that might have been earned on projects not undertaken because resources were expended to convert to ozone-friendly technologies.

Recognizing the difficulties of exact measurement, it is nevertheless possible to see both theoretical and empirical reasons why the push to eliminate ODSs might offer firms direct economic benefits. A sizeable literature documents that companies often do not take advantage of all the profitable pollution-prevention opportunities available to them (Maize 1993/94; DeCanio 1993; Cebon 1992). As a general proposition, this is not surprising; it would be extraordinary if the large, complex modern business organization, spread as it typically is over multiple locations and markets, were able to achieve maximum economic efficiency in all its endeavors. If optimization of productive resources were easy to achieve, the task of management would not be so difficult, nor would it attract the talent it does. Statistical benchmarking studies show considerable room for improvement in input utilization (Button and Weyman-Jones 1992).

Furthermore, if "organizational slack" is present (where slack is defined as "the excess of resources allocated over the minimum necessary to accomplish the tasks assigned" (Antle and Eppen 1985, citing Cyert and March 1963)), then external pressure can be a force driving the firm to greater efficiency. This is, after all, one of the classical arguments in favor of markets---competitive pressures lead firms to get the most out of their personnel and material resources. The same can be true of regulatory pressure. If the externally determined need to eliminate ODSs focuses managerial attention, stimulates technological creativity, and elicits innovative responses from all levels of the organization, then it is quite possible that the regulation has provided a gain to society that goes beyond the primary benefit of protecting the ozone layer.

National regulations to accomplish the phaseout of ODSs have generally involved the setting of performance standards. That is, the regulatory requirement has been to eliminate the

use of ODSs, regardless of the technological route followed to achieve that goal. This approach stands in contrast to the type of "command and control" environmental regulation that specifies particular technologies that must be grafted onto an existing industrial facility. There is usually more room for innovation if environmental regulation takes the performance standard form. Setting performance targets makes it possible to achieve compliance through technologically progressive means, whereas mandating specific technologies often means simply adding a layer of cost to the production process. Allowing technological flexibility enables manufacturers to rethink design issues and approach production processes with a fresh perspective, if such changes can achieve the environmental goal most efficiently. The ODS elimination case provides concrete examples of the economic justification for this approach.

Despite these potential collateral benefits, the changeover to ozone-friendly technologies in many instances will be costly on net to firms and consumers. Some non-ODS methods will have higher operating expenses, and in most cases investments must be made to effect the transition. The relative smoothness of the phaseout up until now may reflect the likelihood that the easiest substitutions were the ones that were made first. Certainly for firms in some countries, the cost or unavailability of capital to implement alternative technologies looms large. The Multilateral Fund, of course, is intended to compensate for incremental costs in Article 5(1) countries when the substitute technologies are more expensive than the ODS technologies they replace.

It is not the purpose of this *Report* to make a final determination of the degree to which the global drive to replace ODSs has increased or decreased the productivity of industry at large. We can only note the phenomena alluded to above, and maintain that the data on industrial change provided by this "natural experiment" should be examined more deeply for underlying patterns. What is clear is that the ODS phaseout experience proves that it is possible for a major environmental concern to be thoroughly assimilated into corporate, governmental, and popular cultures.

B. Differences Across Sectors.

One way of classifying ODSs is by their applications---as solvents, aerosol propellants, foam-blowing agents, refrigeration working fluids, etc. This is the scheme that has been used by the UNEP Technical and Economic Options Panels in the past, and it has the advantage of grouping ODS applications in a way that makes the engineering knowledge generated through the substitution process more easily available across firms. Another way of looking at the ODS applications is by the product markets in which the ODS-using firms operate. This is already recognized to some extent by, for example, splitting mobile air conditioning applications from industrial chillers within the "refrigeration sector."

Technical considerations are one determinant of the speed at which ODS substitution takes place. It is relatively easy to replace CFCs as aerosol propellants, because the engineering problems that must be solved (finding a propellant that does not contaminate the active agent, that can store sufficient energy in compressed form, and that can be incorporated into the

manufacturing process at low cost) are not too demanding. In other cases, however, the applications appeared to be technically difficult, yet substitution proceeded at a rapid pace.

The leading example of this apparent paradox has been the replacement of CFCs (especially 113) as solvents in electronics manufacture. The electronics industry is very far along in the phaseout of ODS solvents as of the time of this *Report*. This is despite the fact that 113 was thought to be so essential to high-tech electronics at the time the original Protocol was negotiated that there was discussion of excluding it from the list of controlled substances (Benedick 1991). The success of the electronics industry in eliminating ODS solvents is due in part to the industry's research orientation and the fact that its products' lifetimes are short, as well as to the strategic importance of the industry. The electronics industry is built on innovation and rapid replacement of established lines. These characteristics gave electronics equipment manufacturers a foundation for the kind of response needed to phase out ODSs quickly.

Other industries are less research-intensive, and have products with lifetimes measured in decades rather than years. For example, household refrigerators are designed to last 20 to 30 years with very low maintenance. Premature introduction of a technology for which the bugs have not all been worked out can be very costly, as a major U.S. refrigerator maker found when it incurred a \$450 million pre-tax loss in 1988 because of having to recall models built with a compressor that had not been adequately field tested (Holusha 1992). Refrigeration is a "mature" industry, in that (at least in the developed countries) the market consists largely of replacement of existing equipment, with some growth associated with new residential construction. In such an industry, the rapid phaseout of CFCs has presented a challenge requiring a new approach to product development.

The refrigeration industry has responded innovatively. For example, in the United States a consortium of 24 electric power utilities sponsored a competition for design and marketing of a super-efficient refrigerator, one that would be up to 50% more energy-efficient than existing comparable models (and at least 25% better than 1993 federal energy efficiency standards), and would be entirely CFC-free. The prize was \$30 million, awarded on a winner-take-all basis. The Super-Efficient Refrigerator Program (SERP) contest was won by Whirlpool, which succeeded in producing a model that exceeded the energy-efficiency target. The Whirlpool SERP refrigerator is approximately 30% more efficient than the current government standard. The refrigerator incorporates only "conventional" components (i.e., no fundamental change in compressor technology or cooling cycle) and uses HFC-134a as its working fluid. At current electricity rates, the refrigerator will save its owner \$15-20 each year in electric bills (hundreds of dollars over the product's lifetime), and will cost no more initially than a conventional refrigerator of the same capacity. Whirlpool plans to market a few hundred thousand units over the next three and a half years (Langreth 1994; *Global Environmental Change Report* 1992).

Stimulated by the imminent elimination of CFC production, the refrigeration industry has a number of other CFC-free and energy-efficient technologies either in early marketing or under development. For heating, ventilation, and air conditioning (HVAC) systems, desiccant cooling, in which heat is exchanged through evaporation and the energy is supplied by combustion (of natural gas, for example) is a potentially attractive alternative to compressor-based cooling cycles (Wald 1992). For appliances, other technologies are being considered, ranging from

vacuum insulating panels (already introduced in a large-capacity refrigerator model in Japan by Sharp Corporation (*Global Environmental Change Report* 1994a)) to thermo-acoustic refrigeration in which a standing sound wave produces the compression/expansion cycle (*Restaurants & Institutions* 1993; Browne 1992; *Scientific American* 1992). Sizeable efficiency gains have been achieved experimentally using hydrocarbon mixtures in a two-evaporator modified Lorenz-Meutzner cycle refrigerator (Liu et al. 1994). Even without fundamentally changing the compression cycle, it appears possible to achieve energy savings through the use of alternative cooling fluids (Zurer 1993b; Liu et al. 1994). Most large German refrigerator manufacturers have launched a hydrocarbon refrigerator or are planning to do so, in addition to offering models that use HFC-134a. Bosch-Siemens recently announced that by the start of 1995, more than 80 percent of its production will use hydrocarbons only, and the German manufacturer Liebherr is likely to follow Bosch's lead (Knight 1994; MacKenzie 1994). United States manufacturers' reluctance to pursue technologies involving flammable working fluids may be linked more to flaws in the U.S. tort liability system than to rational risk or cost/benefit calculations.

Product cycle considerations are important elsewhere within the refrigeration "sector." Automobile manufacturers worldwide are on the brink of changing over completely to HFC-134a in the air conditioning systems of their new models. To accomplish this, the time for redesign of the automobile air conditioner was cut to three years or less. The design cycle for United States automobile producers historically has been five years or more (Dertouzos et al. 1989), although it has been less in other countries. Acceleration of the mobile air conditioner design schedule can be seen as part of a general move in automobile manufacturing towards faster response to changing consumer preferences, and the annual model changeover in this industry offers a natural opportunity for rapid adaptation.

C. Analogies to Other Large-Scale Technological Initiatives.

The global ODS phaseout effort is a policy-driven technological initiative with few historical precedents. Large-scale projects at the frontiers of technology have been attempted before, with mixed success. No one knew whether it would be possible to land humans on the moon by 1970 when President Kennedy announced the Apollo program in 1961. The rockets that eventually would carry astronauts to the lunar surface and back had not been built, although their underlying design and principles were known. It was not clear that humans could function at the requisite level of efficiency under prolonged weightlessness, and the configuration of the Lunar Excursion Module (LEM) was untested in practice. The Apollo project met its timetable, but it was a risky enterprise and one of the lunar voyages (Apollo 13) very nearly ended in loss of the entire crew after an oxygen tank explosion in space (Sagan 1994; Cooper 1973).

NASA's subsequent woes suggest that there are dangers to overcentralization in attempting to implement massive technology programs. The advantages of simultaneous pursuit of parallel strategies, and the difficulties large bureaucracies have in nurturing creativity, bear on the advisability of attempting to accomplish ambitious technological goals through huge government investments. Unlike Apollo, the ODS replacement problem has had the advantage

that the optimal scale of substitute technologies has been within the reach of existing business units.

Another example of a goal-oriented innovation drive is the Fifth Generation Project sponsored by Japan's MITI to create Artificial Intelligence (AI) hardware and software. Although this project produced a substantial body of useful results, especially in the development of parallel processing, it did not achieve its more ambitious AI goals (Sims 1993). It should also be borne in mind that not all technological and scientific challenges are equally tractable. Substantial resources have been and are being invested in the search for a vaccine or effective treatment for AIDS, but so far this problem has resisted solution.

Of course, neither the Fifth Generation, the Apollo Project, nor the search for a cure for AIDS is entirely akin to ODS phaseout. Unlike the Apollo Project, protection of the stratospheric ozone layer has been a global rather than a national effort. Unlike Apollo and the Fifth Generation, ODS replacement has been very widely diffused across industrial sectors and applications, rather than being concentrated in single big push or a small number of industries. The drive to find replacements for ozone depleting substances has had no linkage to the development of weapons systems (although the military has contributed in a major way to the substitution effort). Apollo was a federal program paid for out of government revenues, while ODS replacement, except for those activities supported by the Multilateral Fund, has been financed largely within the private sector.

One feature of the ozone protection effort that is similar to scientific research is the spirit of cooperation that has suffused the community of people devoted to the task. Although elements of commercial rivalry have not been entirely absent, the depth and extent of cooperation has been remarkable. ODS replacement technologies that might, in other circumstances, have been closely guarded as industrial secrets instead have been shared widely and published in trade and scientific journals. Typical of this openness is the annual International Conference on CFC and Halon Replacement. Since the first such conference was held in 1991, attendance has risen to over 2100 participants from more than 50 countries at the third annual Conference in 1993 (*Environment Today* 1993c). These conferences, organized by the Alliance for Responsible CFC Policy (which recently changed its name to Alliance for Responsible Atmospheric Policy) in cooperation with the U.S. Environmental Protection Agency, Environment Canada, and UNEP, are conducted in the style and format of a scientific meeting. The Conference Proceedings are published, and the sessions are open to the public. Perhaps it is fitting that the ozone protection effort, which originated with scientific hypotheses advanced during the mid-1970s and which has been fueled by the accumulation of scientific evidence on the extent and effects of ozone depletion since then, should resemble the process of scientific discovery as much or more than it does the ordinary course of industrial development.

IV. CONCLUSIONS AND GENERAL OBSERVATIONS.

ODS replacement is proceeding at a rapid pace, but continued work will be needed to complete the job with a minimum of cost and industrial disruption. Every effort should be made to manage intelligently the existing stock of ODSs so that otherwise useful capital and durable goods are not rendered prematurely obsolete (see Chapter 7 below). The Parties individually and collectively must recognize that regulatory uncertainty and indecision creates confusion in the minds of consumers and manufacturers, thereby prolonging the use of ODSs and increasing the cost of their phaseout. Judicious use of transitional chemicals such as HCFCs can help speed the elimination of CFCs, without overburdening the atmosphere with chlorine during the transition. The best should not become the enemy of the good; uncertainty regarding the regulatory future of transitional substances can have the perverse unintended consequence of prolonging attachment to CFC technologies, especially in Article 5(1) countries.

The situation of the developing countries remains a critical element in the global effort. Transfer of ozone-friendly technologies to Article 5(1) countries by multinational firms and through government-business partnerships should be encouraged by all reasonable means. The pipeline of assistance through the Multilateral Fund to compensate Article 5(1) countries for the incremental costs of avoiding ODS use must remain filled. Resources of the Multilateral Fund should be maintained at a level adequate to carry out its mandate.

Enterprises around the world should view the elimination of ODSs as an opportunity for technological and organizational innovation. Given that new investments have to be made to replace older technologies, private firms and state enterprises can take advantage of the situation by (a) implementing up-to-date methods, (b) rethinking their design and production processes to gain the maximum collateral benefits from the required new investments, and (c) examining whether the experience gained in ODS replacement can be applied to other aspects of their operations. Even if innovation driven by overriding environmental concern (such as protection of the stratospheric ozone layer) is not narrowly profitable, it should be possible for organizations to draw useful lessons for improving their overall efficiency.

Government regulators should notice the advantages of a cooperative and "user-friendly" approach to the industries engaged in ODS replacement. A great deal has been accomplished to date through the exchange of information, facilitation of technology transfer, and focusing the attention of top management on the ozone depletion problem. In part, the high degree of cooperation between industry and government rests on the scientific foundation of our growing understanding of the causes and effects of ozone loss. Rational individuals, whether members of environmental NGOs, government regulatory agencies, or local or multinational corporations, have a strong interest in avoiding the planetary disasters that would have accompanied unchecked growth in ODS emissions.

At the same time, we should not lose sight of the fact that the ozone protection movement has been built upon appeals to the social responsibility of individuals, firms, and governments, as well as to their self-interest. It is one of the tasks of policy-makers to give tangible institutional form to the shared values and commonalities that unite diverse groups. When, as in the case of

ozone layer protection, the underlying values are deeply and widely held, responsible authorities in government and the private sector have a unique opportunity to maximize agreement among all concerned. The ozone protection effort has demonstrated just how far such a process of consensus-building can extend.

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CHAPTER 2**THE IMPLEMENTATION OF THE MONTREAL PROTOCOL****I INTRODUCTION**

There is a learning process embedded in the accumulating experience with implementing the Montreal Protocol. It is clear that the main actors are moving up the "learning curve". Key examples are as follows:

- (a) both donors and recipients of financial assistance under the Protocol are learning how to work together to achieve a common global environmental objective;
- (b) the evolving policies and operational guidelines of the Multilateral Fund demonstrate a deepening understanding of how to make effective use of the incremental cost concept;
- (c) the Implementing Agencies are streamlining their responses to the evolving performance requirements of the Multilateral Fund;
- (d) industry's creative responses to the technological challenges posed by the ODS phaseout schedules demonstrates the power of its cumulative effort to deliver cost-effective solutions to a global environmental problem;
- (e) developing countries, operating under Article 5(1), are taking advantage of the Multilateral Fund to strengthen their institutional capacities to manage ODS phaseouts; and
- (f) other non-governmental organizations are finding new ways to use their environmental commitment and resources to influence the implementation process.

This mutual learning process has nurtured an atmosphere of trust and confidence between the main actors that must be brought to bear on the resolution of the remaining challenges facing the implementation process.

A. Background on the Multilateral Fund.

The Montreal Protocol (MP) was agreed in 1987. At that time, the Protocol did not include explicit provisions for technical assistance to developing countries.

In 1990 the Parties agreed the London Amendment to the Protocol; it established the Multilateral Fund (MF) to assist the developing countries, operating under Article 5(1), to achieve compliance with the Protocol. A list of activities eligible for Multilateral Fund assistance was also negotiated during the London Meeting of the Parties (**Indicative List of Categories of Incremental Costs, 1990**).

The activities of the Multilateral Fund are managed by an Executive Committee (ExCom) assisted by its Secretariat. It determines the policies and operating procedures, and approves all financing undertaken by the Multilateral Fund. The Executive Committee has approved operating guidelines for the Fund (**Multilateral Fund Information Package: "Procedures, Policies, Guidelines, and Criteria", 1993**).

The Parties agreed to an initial funding level of US\$240 million during 1991-1993. At the 5th Meeting of the Parties in Bangkok (November 1993), the Parties agreed to a second tranche of US\$510 million for the period 1994-1996.

The Fund invests in projects on a "first-come, first-served" basis ie there are no pre-set allocations of the Fund for each Article 5(1) Party. These projects are carried out by the Implementing Agencies (IAs). The Fund engaged three IAs to assist the Article 5(1) countries in developing projects for ODS elimination ie the United Nations Environment Programme (UNEP); the United Nations Development Programme (UNDP); and the World Bank (WB). UNEP, as an implementing agency of the Fund, takes the lead role in the scientific assessment of ozone layer depletion, technology and economic assessment of ODS alternatives, and the special IE/PAC program for the dissemination of technical information. UNDP is responsible for developing and implementing technical assistance programs whereas the World Bank is responsible for the investment projects of the Fund. The specific roles of the three IAs were assigned in recognition of their respective expertise. Subsequently, the United Nations Industrial Development Organization (UNIDO) became a fourth implementing agency.

This attempt to exploit the existing expertise of established international institutions as implementing agents for the Executive Committee has revealed some coordination problems; these are being addressed by the Executive Committee. In particular, the IAs have been competing with each other for investment projects on behalf of the Article 5(1) countries with results that, whilst not without benefit, have raised questions about the efficiency implications of these practices.

On the country level, the IAs have concentrated on preparing Country Programs (CP)- including data collection on ODS uses - and on investment project identification and preparation. These efforts have sometimes produced confusion and duplication of effort which reflects both the weak institutional capacities of the Article 5(1) countries and the competitive behaviour of the IAs in seeking "ownership" of specific project proposals. The creation and strengthening of the National Ozone Units (NOUs) in the Article 5(1) countries and the endeavors of the Multilateral Fund and the Implementing Agencies have been important in progressing the resolution of these operational inefficiencies.

Further efforts are required to accelerate the implementation process, especially to raise the efficiency of technical assistance activities and project financing. Progress is being made through the work of the Executive Committee and the Secretariat, in cooperation with the Implementing Agencies, in clarifying policy issues, operational procedures and the respective roles of the IAs in the implementation process to resolve remaining inefficiencies..

Nevertheless, the Multilateral Fund has approved over 600 activities costing US\$191 million in over 73 Article 5(1) countries; and a further US\$6.9 millions has been provided by seven donor countries for bilateral projects. Once fully implemented, these projects are expected to phase out over 40,000 ODP tonnes of ODSs; total ODS use for all Article 5(1) countries in 1993 is estimated at 235,000 tonnes (UNEP 1994).

The World Bank is the Implementing Agency for 197 projects amounting to 53.3 per cent of disbursed MF funds; UNDP is implementing 223 projects amounting to 27.1 per cent of disbursed funds.

In terms of sectoral allocations, Table 1 shows that the largest shares have been allocated to the refrigeration (US\$70.37 millions) and the foam sectors (US\$48.79 millions). Projects affecting several sectors at once were allocated US\$36.76 millions eg preparation of country programs, investment projects and global conversion projects (MF 1994).

The data in Table 1 do not include (1) the funds provided by governments and companies in the Article 5(1) countries to phase out ODS uses for commercial reasons eg competitiveness in export markets; (2) funding provided by donor countries to support other activities related to ozone layer protection eg meteorological network systems to monitor ozone depletion in Article 5(1) countries; or (3) in-kind contributions from companies or other institutions in the donor countries to support technical assistance in the Article 5(1) countries eg International Cooperation for Ozone Layer Protection (ICOLP).

TABLE 1:

PROJECT ALLOCATIONS BY IMPLEMENTING AGENCY AND SECTOR (AS AT JULY 1994)
(IN THOUSAND US\$)

Sector	IBRD	UNDP	UNEP	UNIDO	Bilateral	Total
Aerosol	9,180	384	130		6	9,700
Foam	20,919	25,666		2,110	91	48,786
Fumigant		87				87
Halon	3,203	2,046	280		2,568	8,097
Multi-sec.	5,386					5,386
Other	4,720					4,720
Production	240					240
Refrig.	37,477	13,061	856	17,187	1,787	70,368
Solvent	8,373	4,111		684	1,207	14,375
Several	16,272	8,444	9,768	944	1,330	36,758
Total	105,770	53,799	11,034	20,925	6,989	198,517

Source: Multilateral Fund, consolidated Progress Report (September 1994)

B. Evolution of the Multilateral Fund

The Multilateral Fund began operating in 1991. It is a unique endeavor in global environmental cooperation for which there were no operating models to emulate. In its first year of operation, The Executive Committee set up the Secretariat and recruited its professional staff. It also initiated policy guidelines and operational procedures as well as taking decisions on those issues that arose out of the reviews of the project proposals presented by the Implementing Agencies. The benefits of these efforts can be seen in the increasing efficiency with which decisions on subsequent project proposals have been taken.

Following their service agreements with the Executive Committee, the Implementing Agencies have been refining their operational procedures to meet the specific needs of the Multilateral Fund. Some of their procedures have had to be redesigned and new policy, and new operational issues resolved eg negotiating "the letter of agreement" ; identifying "focal points" in the Article 5(1) countries; providing technical support; and creating appropriate reporting systems to manage these new activities. In practice, the process of identifying and responding to the needs encountered in the Article 5(1) countries and in presenting their findings to the Executive Committee has been a time-consuming task. It involves putting technical missions in the field, preparing submissions to the Executive Committee and dealing with a range of new policy issues the resolution of which can make it necessary to reformulate individual project proposals. As part of this process, the Implementing Agencies are required to prepare full reports three or four times each year on their respective activities - current and prospective - and to submit their work programs. Most of the operational difficulties have been resolved and, more recently, the Article 5(1) countries have been receiving more active and effective support - and faster results - with their project proposals.

Following the progress made in establishing the National Ozone Units and in the preparation of country programs, these Units are reporting a lack of support from the Implementing Agencies - and their consultants - in taking the implementation process beyond the gaining of Multilateral Fund approval for their respective country programs.

There have also been difficulties in selecting ODS alternatives. Over time, however, the identification of effective ODS alternatives gradually has become much clearer, the main actors in the implementation process have moved up the "learning curve" and the Multilateral Fund is enhanced its capacity to accelerate progress. Even so, it is important that any remaining sources of delay in the implementation process should be dealt with as quickly as possible.

So far, the most rapid progress has been achieved in the aerosol and solvent sectors where cost-effective solutions have been readily available. Yet, even in these sectors, the solutions range from

- (a) those of a generic nature for a small number of readily identifiable users to
- (b) those of a specific nature for large numbers of individual small users that can be hard to reach through technical assistance programs.

Most of the research and technical assistance effort has been concentrated on the refrigeration and foam sectors. These sectors represent the major share of ODS use, but also face substantial uncertainty over the selection of the most appropriate ODS alternatives. The economic implications are also very large given the risk of triggering early replacement or obsolescence of large stocks of equipment by committing to existing alternatives prematurely.

Tactically, the large ODS using industries are targeted first as they offer cost-effective opportunities for ODS reduction. Subsequently, however, the challenge moves on to the small and medium enterprises (SMEs) which tend to be locationally dispersed, difficult to reach, and lack the skills required to prepare projects or to understand the available technical options and their implications. Also, SMEs tend to lack the formal organizational structures or regular supplier networks that would otherwise be well-placed to help them to select and implement ODS alternatives.

In most Article 5(1) countries, the SMEs sector accounts for major shares of industry's output and employment, and it is growing faster than the economy as a whole. The management skills, financial resources and technical expertise of SMEs tend to be low, thereby increasing the cost of assisting them. Specific proposals to deal with these problems are being developed eg UNEP IE/PAC's support to National Ozone Units; and the World Bank's proposed "umbrella agreements" to provide more cost effective financial support for a group of small, but related, individual investment projects.

Whilst these initiatives will help the implementation process in the Article 5(1) countries, the need to develop user-friendly guidelines for investment project submissions remains a top priority. Securing agreement could prove difficult to achieve, but the Implementing Agencies and the Article 5(1) countries require guidelines that minimise the risk that project applications will fail to gain Executive Committee approval on procedural grounds. Their successful negotiation could substantially reduce the cost of the implementation process.

The existence of the Multilateral Fund provides a signal to ODS producers and users in the Article 5(1) countries that financial support is possible for an early ODS phaseout. If the governments are convinced that the technical and financial assistance is available and that the guidelines and procedures necessary to acquire it are fully understood, then industry is much more likely to pursue early ODS phaseouts.

C. The Multilateral Fund as a Model.

The structure of the Executive Committee of the Multilateral Fund and its procedures are innovative in several important aspects.

It was established with equal voting rights for the donor and Article 5(1) countries. The Executive Committee has 14 Parties as members; 7 are donor countries and 7 are Article 5(1) countries. It has become established practice for Parties to share the seats thereby increasing the number of Parties involved in the decision-making process. The voting procedure is based on a double majority system ie decisions require a simple majority in both the donor group and the Article 5(1) group of Parties. So far, all decisions have been by consensus; there has been no need to use the voting mechanism. These procedures and practices have contributed to a high degree of consensus and understanding between the

Parties.

The Executive Committee has also transformed the incremental cost concept into an operational tool for guiding the allocation of financial resources. The Multilateral Fund, established under the Montreal Protocol, is intended to meet all agreed incremental costs of eligible Parties to enable them to comply with the control measures of the Protocol. The Protocol provides an Indicative List of Categories of Incremental Costs (ILCIC). While the ILCIC remains the guiding principle for defining what constitutes incremental costs, the experience of the Implementing Agencies and the Executive Committee in dealing with projects has helped to transform indicative categories into operational procedures. Incremental cost is broken down into the four categories: baseline costs, project costs, the economic life of the project, and the discount rate. To calculate the incremental cost of a project, the costs of each of these components must first be estimated. To improve the consistency in the decision-making process, the Executive Committee has negotiated mutually accepted interpretations of a number of policy issues and operational procedures of importance to taking decisions on investment project submissions by the Implementing Agencies.

Both the voting mechanism and the incremental cost concept of the Montreal Protocol were brought into the discussion of the recent restructuring of the Global Environmental Facility (GEF). The GEF has not adopted the Protocol's voting mechanism nor an indicative list of categories of incremental costs. However, it does provide for the financing of "agreed full incremental costs". These differences in operating procedures have a bearing on the implementation of the Protocol to the extent that the GEF funds the incremental costs of the "transitional economies" of Central and Eastern Europe; they do not meet the criteria for Parties operating under Article 5(1) and therefore do not have access to the Multilateral Fund. However, it is thought unlikely that there will be any significant differences between the operating procedures of the GEF and the Multilateral Fund with respect to the implementation of the Montreal Protocol.

II. TECHNOLOGY TRANSFER

A. Diffusion.

The successful implementation of the ODS phaseout in the Article 5(1) countries depends largely on the transfer of technology from the industrialized countries. Their technological responses to accelerated ODS phaseout schedules have generated leadership in the development of ODS alternatives. The technical "know-how", equipment and ODS substitutes that they have developed are resources that the Article 5(1) countries need to draw upon in meeting their commitments under the Protocol.

The Parties to the Protocol have emphasized the importance of using the best available technologies. They have agreed, in Article 10A, that technology transfer to the Article 5(1) countries should be transacted under "fair and most favorable conditions". It should include production methods, equipment, instruments, and supporting services of information, training, and management. It is important that such transfers are consistent with sustainable development criteria and respect intellectual property rights.

Examples of successful diffusion can be readily identified. Most are the result of normal commercial transactions. Others originate in the collaborative efforts of companies in pursuit of their mutual interests in the implementation process. Good examples are provided by consortia such as PAFT, AFEAS and ICOLP. They are making important contributions to the ODS phaseout process through the transfer of information, "know-how" and technologies, and through the testing of the efficiency and suitability of newly developed ODS alternatives.

B. Channels.

Technology flows from stake-holders to users through various channels. In practice, the channel used depends on the following factors:

- (a) industrial, trading, technological and financial relationships between countries and commercial enterprises;
- (b) the quality of the recipient's economic, political and social infrastructure;
- (c) regulations and practices regarding investment and the protection of intellectual property rights (IPRs);
- (d) the availability of appropriate technical and management skills;
- (e) the availability of finance; and
- (f) the services of institutions with the capacity to facilitate technology transfer.

It is in the interests of the Article 5(1) countries to direct their investment towards proven technologies. Faced with tight resource constraints, it is important for them to minimize the risks of investing in technologies that have not yet been fully tested or are still in the research stage.

Firms in Article 5(1) countries operating under licenses or as subsidiaries of multinational corporations can have prompt access to new ODS alternative technologies through the commercial interests and resources of their parent corporations. Such corporations can ensure effective technology transfer through their management controls over policy, personnel, training, technology and financial resources.

For most firms in the Article 5(1) countries, the transfer of ODS alternative technologies is more problematic. Typically, these are small or medium-sized enterprises (SMEs) with limited capacities to switch to ODS alternative technologies on their own. They have to make use of the services of several independent organizations - some domestic and others international - with different and often competing managements.

The Multilateral Fund is the main channel under the Protocol for facilitating technology transfer to the Article 5(1) countries. It does so largely through its Implementing Agencies. This operating structure offers advantages through taking advantage of the expertise of established international institutions, but it also has inherent potential to generate problems of coordination.

The Protocol also accommodates bilateral technology transfer programmes. Up to 20 per cent of a donor's assessed contribution to the Multilateral Fund can be allocated to bilateral assistance programmes. Where effective, bilateral assistance is well-received by the Article 5(1) countries.

In the Article 5(1) countries, the National Ozone Units are facing practical difficulties in coordinating the activities of the multifarious groups that have interests in the implementation process. Given the complexity of the process and the limitations on their resources and powers, the National Ozone Units face a demanding task.

C. Joint Ventures.

Joint ventures between local firms in the Article 5(1) countries and the stakeholders in the industrialized countries have been successful in a number of sectors, but they are not yet prominent in ODS phaseout activities. Their potential contribution suggests that they should be encouraged.

The opportunities for joint ventures in Article 5(1) countries is improving as they move towards more open, free market economies. As privatisation of public sector industries proceeds, the responsibility for technology transfer is shifting from public authorities to private enterprises. These firms are bound to encounter constraints on the availability of technical information, equipment, technical and management skills, and finance in their efforts to introduce ODS alternative technologies. Joint ventures offer the possibility of easing these constraints. Of course, resources do not come free. There is a price to be paid in terms of management control and profit-sharing.

Making progress with joint ventures requires more intensive efforts to match up potential partners. Trading relationships developed through normal commercial channels can be a promising way of identifying potential partners. For example, the efforts of UNEP IE/PAC to disseminate technical information regarding ODS alternative technologies and their suppliers, as well as providing access to a database on national ODS phaseout activities, may also provide opportunities for bringing together potential partners.

D. Categories.

Three categories of technology transfer to the Article 5(1) countries can be identified.

- (a) The transfer of production technology for phasing out high ODS consumption. These tend to be Article 5(1) countries with large domestic markets eg China; India; Brazil.
- (b) Technology transfer to countries with moderate ODS consumption used

largely in the production of manufactured goods for export eg Thailand and Egypt.

- (c) The transfer of recycling technologies to provide ODSs for the recharging of existing equipment eg The Cameroons.

The cost-effectiveness of implementation programmes in Article 5(1) countries could be improved by encouraging the National Ozone Units to focus on giving priority to relatively large ODS usages for which there are readily available ODS alternatives that make possible ODS reductions at relatively low cost per ODP tonne. Management information of this kind is important to identifying phaseout strategies to guide the implementation process -including the submission of project proposals to the Multilateral Fund.

E. Selection of Technologies.

The selection of ODS alternative technologies should be made with respect to explicit criteria. Specifying the criteria and of evaluating performance helps to clarify the respective contributions of alternative technologies to the national ODS phaseout strategy. In particular, these procedures would help those take decisions on the proposals of competing suppliers eg commercial managers and the members of the National Ozone Units.

Appropriate criteria might include the following:

- (a) technical feasibility, commercial availability and performance characteristics;
- (b) economic efficiency, taking into account all incremental costs and benefits eg investment costs; recurrent costs; dislocation costs; infrastructure costs; market prospects for the relevant products; calculated present value; and calculated incremental cost;
- (c) human health and safety aspects;
- (d) implications for other environmental objectives eg water quality; atmospheric emissions;
- (e) local capacity to manage the technical, economic financial, and political dimensions of specific projects; and
- (f) the implications for wider economic, social and political objectives over and above the net benefits of ODS phaseout itself.

F. Special Circumstances of Developing Countries.

Particular attention must be given to the special circumstances of the Article 5(1) countries with respect to their influence on the technology transfer process.

The economies of the Article 5(1) countries have relatively large, though under-resourced, small and medium-sized enterprise sectors (SMEs). They contribute substantially to national output and have relatively high rates of growth. However, their technical and management skills are not well-developed and they are handicapped in the technology transfer process by their limited knowledge of the foreign languages that are needed to gain access to new technologies, management practices and the services of international organizations. Furthermore, they tend not to have ready access to the services of local trade associations or of similar institutions.

These special circumstances need to be taken into account in efforts to facilitate technology transfer to Article 5(1) countries. In particular, it is recommended that:

- (a) only commercially available, proven and widely-used equipment that is matched to local skills and supply infrastructures should be considered;
- (b) capital and skill limitations should be recognized;
- (c) administrative procedures should be simplified;
- (d) implementation through official agencies should not distort competition in local markets unnecessarily; and
- (e) institution-building for local industry should be encouraged (eg strengthening the services provided through local trade associations).

III. ISSUES ENCOUNTERED DURING IMPLEMENTATION

The establishment of the Multilateral Fund in 1990 was an important step for the Montreal Protocol. Since that time, many policy and operational issues have been addressed, and much has been learned about the special problems facing the Article 5(1) countries. This section identifies some current implementation issues and discusses options that might be taken to address them.

A. Priorities of the Article 5(1) Countries.

Article 5(1) countries have many pressing economic, social and political problems that compete for resources against demands for environmental protection eg protecting the ozone layer. In some Article 5(1) countries there is no governmental organisation specifically

responsible for environmental protection; and in cases where one does exist, the responsibility for ozone layer protection is often divided amongst several governmental organizations such as Foreign Affairs, Meteorology, Health, Housing, Agriculture, etc.

In recognition of these circumstances, the Executive Committee of the Multilateral Fund is resourcing the establishment of National Ozone Units (NOUs). To date, the Fund has helped to establish 42 NOUs. Typically, they are staffed by 1 to 3 full time professionals, perhaps with additional support staff, to work with NGOs, industry associations, ODS users and suppliers, academic experts and individual ODS users. The Multilateral Fund resources are devoted exclusively to ODS elimination activities. It is in the best interests of the Article 5(1) countries to recruit personnel of high quality to manage these activities. Also, the NOUs must be given sufficient powers and resources to ensure that they can make substantial contributions to the development of ODS phaseout policy.

B. Monitoring.

The capacity of the customs authorities in the Article 5(1) countries to monitor imports of ODSs has been an area of particular concern. There is scope for the Parties to facilitate the introduction of cost effective mechanisms to ensure improved reporting in the Article 5(1) countries. In response to these concerns, Decision VI/14A was adopted by the Parties in October 1994. It requests each Party operating under Article 5(1) that requires controlled substances referred to in Articles 2A and 2E from another Party to furnish, with effect from 1 January 1995, to the Government of the supplying Party within 60 days of such imports a letter specifying the quantity of the substances imported and stating that the substances are to be used for the purposes of meeting domestic needs.

C. Technology.

Technological advances in ODS alternatives are accelerating. The Article 5(1) countries do not want to become increasingly dependent on "yesterday's technologies", especially as they are seeking to expand their export markets. However, they need more help in selecting the most appropriate ODS alternative technologies - and to ensure that they are not used as "testing grounds" for unproven transitional technologies.

D. Information.

Information is a key resource. However, it must be well-targeted, adapted to specific requirements, and cost-effective. Firms in the Article 5(1) countries need to understand their commitments and opportunities as Parties eg the timing and implications of ODS phaseouts and how to make full use of the assistance available to them as Parties. Expertise must be more fully exploited whether from local sources or from experts working on behalf of the implementing agencies of the Multilateral Fund.

Experience shows that many Article 5(1) countries do not fully understand how to satisfy the requirements of the Multilateral Fund when seeking approvals for their investment projects. They require ready access to information regarding the role, policies and operating procedures of the Multilateral Fund and its implementing agencies. They would also benefit from up to date case studies of approved and implemented investment projects. These and

other ways of ensuring that the Article 5(1) countries have clear and specific guidance regarding the Fund's criteria for project approval would help to improve the efficiency of the implementation process.

E. Training.

Successful technology transfer is unlikely without structured training programs to ensure that the recipients can make effective use of the technology. Group training in the form of highly focused workshops has proved effective. However, experience shows that it is necessary to integrate such workshops within the technology transfer process itself to ensure success.

F. Non-governmental organizations.

Non-governmental organizations (NGOs) have been influential in the ODS phaseout in the developed countries, and could also play a significant role in the Article 5(1) countries. The NGOs have a broad base which reaches into academia, industry associations, voluntary groups and various individuals committed to protecting their environment.

G. Non-Parties.

There are currently over 130 Parties to the Montreal Protocol. However, there remain about 30 or so developing countries that have yet to ratify the Montreal Protocol. It is important to continue the efforts to persuade them to into comply with the Protocol. These countries are small users of ODSs - none are ODS producers - mainly for the recharging of existing refrigeration equipment. The only way in which they can ensure future supplies of ODSs is by becoming Parties. The Ozone Secretariat is charged with promoting the Protocol and, through its outreach activities, it is well-placed to make these countries aware of the benefits of becoming Parties to the Protocol.

IV. CONCLUSIONS

There is evidence to demonstrate that the main actors in the implementation process are moving up the "learning curve". The unique nature of the Protocol has required the forging of new ways to gain the necessary widespread international commitment to its global environmental objectives. New mechanisms have been designed and implemented to facilitate this process, some of which could be transferable to the design of other international environmental agreements. Much has already been achieved, especially in the accelerated ODS phaseouts in the industrialized countries.

The action is moving increasingly towards the implementation process in the Article 5(1) countries. Their success is being greatly aided by the technical innovation, "know-how", equipment, ODS substitutes, management practices and cooperative technology transfer initiatives of industry in the industrialised countries. To further assist the Article 5(1) countries, the Parties have established the Multilateral Fund to help them to strengthen their institutional capacities, to finance information and training programs, and to fund the incremental costs of ODS phaseouts.

The implementation process in the Article 5(1) countries is at an early stage. It is not surprising that the Multilateral Fund and its Implementing Agencies have faced many challenges in establishing their policy guidelines and operational procedures. Progress in achieving ODS reduction in the Article 5(1) countries through the Multilateral Fund has yet to gather pace. However, good progress has been made in establishing the foundations of a process that is expected to deliver a sharp acceleration in its contribution to the phaseout process as projects in the "pipeline" move through from disbursements to the implementing agencies to completed ODS reduction projects in the Article 5(1) countries.

Many challenges to the success of the Montreal Protocol have already been overcome; others are being addressed by the Parties and by other main actors in the implementation process. Perhaps the most testing of these challenges are those that must be overcome to ensure that the resources of the Multilateral Fund will be both adequate to the task and efficiently used as the implementation process gathers pace amongst the Parties operating under Article 5(1).

CHAPTER 3**ECONOMIC EFFICIENCY OF THE IMPLEMENTATION PROCESS
IN THE ARTICLE 5(1) COUNTRIES****I INTRODUCTION**

This chapter evaluates the economic efficiency of the implementation of the Montreal Protocol, as it applies to Article 5(1) countries. The question of efficiency is clearly important. The Fifth Meeting of the Parties to the Protocol agreed an amount of \$510 millions. for the period 1994-1996 as a replenishment of the budget for meeting the incremental costs of Article 5(1) countries in phasing out ozone depleting substances (ODSs). By any standards this is a large amount and it is in all parties' interests that the funds are used in a cost effective manner. Unfortunately, given the complexities of the institutional arrangements associated with the phaseout, it is not easy to assess this cost effectiveness. This chapter looks at the evidence, draws some limited conclusions from that evidence, and makes a number of recommendations regarding future implementation procedures.

The instrument that is potentially most helpful in ensuring efficiency and cost effectiveness is the country program or phaseout strategy for ODSs. These are undertaken by the countries concerned, with the assistance of the implementing agencies (World Bank, UNDP, UNIDO and UNEP), or bilateral donors (i.a. USEPA, UKODA). Ideally they should identify the least cost options within each country for the phaseout of ODSs. These options should influence the work programs of the implementing agencies in their selection of projects to submit to the Multilateral Fund for funding approvals.

While the country programs have been found to be useful exercises, they still leave gaps to be filled. The main difficult is to relate them to specific actions undertaken in the short term to phaseout ODSs. Although, as stated above, the strategy should lay out a series of measures that need to be undertaken as part of an efficient phase out program, in practice the activities of the Bank, UNIDO, UNDP and UNEP are only partly guided by the strategy. A discussion of the country strategies is given in Section 2 of this chapter.

Section 3 looks at measures of efficiency based on what has actually been achieved and what the Secretariat of the Multilateral Fund has in its pipeline of activities. These are partly based on costs of phaseout, including administrative costs. There is not that much to go on, and there are major problems of consistency in the reporting of data. However, the section summarizes what is available. From this it is possible to identify certain measures that should be taken to increase the efficiency of the investments and other activities planned by the implementing agencies.

Section 4 reviews a number of areas of broader institutional reform, through which increased efficiency can be realized. These include (a) the roles of the Ozone Operations Resources Group (OORG) of the World Bank as a consultative body, and the Technology and

Assessment Panel of the Montreal Protocol Secretariat; and (b) the possible interactions of the Multilateral Fund with the Global Environment Fund (GEF).

The chapter draws on various documents put out by the implementing agencies, as well as the Fund's secretariat. It has not, however, been able to evaluate the GEF's own ozone projects and compare them with those carried out under the Multilateral Fund. Hence any views on the relative strengths and weaknesses of the two institutions are limited.

II ECONOMIC EFFICIENCY AND THE DESIGN OF A PHASEOUT STRATEGY

At the early stages of setting up a Multilateral Fund to assist the Article 5.1 countries, a good deal of attention was devoted to the question of the incremental cost of phasing out ODSs in those countries. Estimates of these costs were made for a number of countries, and some global estimates also arrived at. Since then the implementation of the Protocol requires countries to prepare phaseout strategies (country programs) which have to be submitted to the Multilateral Fund for approval. Approval of the program, however, does not constitute approval of its estimated total cost as a budget; nor of any projects that might be mentioned therein. The Multilateral Fund can only make financial commitments to implementation projects, which are approved individually.

As of September 1993, 44 country programmes had been initiated, of which 27 had been approved. Their estimated unit cost of phasing out ODSs in US dollars per ton are:

Algeria	(1,921)	Jordan	(16,688)
Burkina Faso	(7,017)	Malaysia	(60,915)
Cameroon	(34,073)	Maldives	(N.A.)
Chile	(1,822)	Mauritius	(112,573)
China	(38,203)	Mexico	(8,929)
Costa Rica	(2,804)	Panama	(5,812)
Cuba	(4,293)	Philippines	(9,146)
Ecuador	(8,196)	Senegal	(N.A.)
Egypt	(24,250)	Syrian Arab	
Fiji	(N.A.)	Republic	(55,618)
Ghana	(N.A.)	Thailand	(N.A.)
Guatemala	(3,400)	Turkey	(35,201)
India	(150,380)	Uruguay	(N.A.)
Iran	(10,225)	Zambia	(233,636)

The data are from the Multilateral Fund, November 1993. An "n.a." indicates that insufficient information was given to calculate the unit cost of phaseout. The figure reported is the unit cost of phaseout over a given period (which varies from as little as three years to as much as 17), of a certain amount of the present consumption of ODSs. Thus if a country is proposing to eliminate 35 percent of ODSs in the next three years and gives a unit cost for that period, the unit cost is calculated by dividing the cost by the amount eliminated.

While there are many reasons why these figures should differ, there are also some why they should be of similar orders of magnitude, at least for countries at similar levels of development and with similar technologies. Thus a unit cost for India that is four times that of China; or a unit cost for Zambia that is seven times that of Cameroon need explanation. No such explanation appears to be available.

Although the guidelines for preparing the country programs are set by the Multilateral Fund, it is very likely, given the varying levels of internal capacity for such work, the different agencies assisting them, and the range of possible underlying assumptions, that the strategies are not fully comparable. The costs of phaseout represented by these countries vary enormously and it is difficult to see how the underlying strategies could be the basis of an overall international cost efficient strategy¹. Further investigation of these differences would be instructive, and might yield valuable information for the review and refinement of country programs.

The process of arriving at a country strategy is a complex one, in which present and future costs have to be traded off. A large investment in phasing out ODS use now may result in higher costs in the immediate future but would save even more in the longer term, when industry has expanded its use of ODSs. The World Bank has been refining the process of creating these strategies, and of estimating the incremental costs. Its work in this area is summarized in the papers by King and Munasinghe, 1993; Bendtsen, 1993; Mason, 1993; Widge, 1993; and Catanach, 1993.

The summary discussion by King and Munasinghe provides a conceptual framework for estimating incremental costs and designing phase out strategies. In principle what they are proposing accords with a common sense approach. The following steps are involved:

- (a) Scenarios need to be identified for rates of growth of demand for the relevant products as well as the costs and availability of substitutes.
- (b) A baseline calculation of the use of ODSs as well as the costs associated with their use has to be made.
- (c) A review of the technical options for substitution has to be carried out and a series of alternative strategies that meet the phaseout requirement has to be defined.

¹Ideally one should compare the costs of the different countries in phasing out ODSs over the same period. Unfortunately the information for such a comparison was not available. It should also be noted that the costs of phaseout in the text are undiscounted.

- (d) The costs associated with the alternative strategies have to be calculated.
- (e) The benefits associated with both the baseline scenario as well as the alternative scenarios have to be calculated. Usually these are simply the value of the production of the final goods in each case.
- (f) The incremental costs are the difference between the baseline costs and the alternative strategy costs; less the difference between the baseline benefits and the alternative strategy benefits.

Guidance in designing a strategy is provided by the Bank documents. The following advice is given:

- (a) Three scenarios should be examined; a reference growth scenario, a high growth scenario and a low growth scenario. Costs of substitutes and their availability should be agreed to in an international context.
- (b) The definition of the baseline is problematic as has been recognized from the earliest stages of the discussions of the Multilateral Fund. A "Business As Usual" baseline is taken in preference to an optimal development path because the Protocol stipulates that the baseline include existing economic and industrial policy. However, the Protocol also stipulates that only domestic needs be included. This has been interpreted to mean that production of ODS-dependent goods for export cannot be included in the baseline; nor should the growth in "demand for ODS dependent goods beyond the point where additional capacity is required" (King and Munasinghe, op. cit.).
- (c) The alternative options should provide the same amount of final goods and services. Strategies being considered are: allowable (actions are delayed to the last possible moment); accelerated (actions are taken as soon as technically possible); and optimal (actions are taken to give the lowest incremental cost). A National Ozone policy that supports each strategy should also be designed.
- (d) The costs required for each strategy are the economic costs, which include adjustment costs and costs of information etc. Adjustments have to be made for non-efficient prices and care has to be taken not to double count costs (eg the costs of the substitutes as well as the higher costs of manufacturing the goods that use the substitutes as inputs).
- (e) There is no clear guidance on how domestic benefits should be calculated. Generally it is assumed that the benefits in the baseline and the alternative scenario are the same. This does not allow for gains from the adoption of more efficient technology, or from the increased potential for exports of the new products. It is mentioned, for example, that one benefit could be the provision of testing facilities for non-ODS equipment that will prove to be useful in general testing. Such benefits are not estimated. It should also be noted that we are not referring here to global benefits -- i.e. those associated with the phaseout of ODSs. Such benefits are never calculated in any of the case studies.

If the country programs described above had been carried out using these guidelines (as supplementary to the Multilateral Fund's Guidelines), it is inconceivable that such large differences in costs of phaseout between countries could emerge.

The World Bank also conducted a number of case studies on the design of the country strategies, using these guidelines. These are reported in the papers referred to above and cover: Egypt, Jordan, India, Turkey, Thailand, Tunisia and Zimbabwe. It is not clear how, if at all, the World Bank's Case Studies relate to the Country Programmes for Egypt, India and Turkey. From an assessment of the data available it would appear that they have very little in common. Table 3.1 below summarizes the findings of these country case studies. Nothing is reported for Jordan, Turkey and Zimbabwe as there are very few numbers for those countries. In each case the unconstrained demand for ODSs was calculated as were the incremental costs of phasing out the use of the controlled substances over the period 1991-2010. Unlike the Country Programmes, the denominator is the total amount of ODSs that would have been used in the phaseout period had there been no Protocol. The case studies show some variation in the cost per ton of ODS removed, but nothing like the variation in the Country Programmes. Part of the difference in the case study figures is due to differences of coverage (eg if costs of information, publicity etc are included); and part to different discount rates. It may also be explained by the fact that some countries have economically inefficient industrial strategies, in which case the costs of making changes could be much larger.

The other point to note about the case studies is that an optimum scenario, by which is meant one that minimizes the incremental cost given the present industrial policies, is anything between 20 percent to 78 percent less than the typical or allowable scenario. Generally the optimum scenario involves a combination of early action in introducing substitutes in the refrigeration sector and developing a strong recycling program to maintain the life of existing equipment that uses ODSs². The clear message from these calculations therefore is: (a) the differences between allowable and least cost scenarios can be very large, (b) differences between countries in costs per ton removed can be very large and (c) strategies adopting recycling and early substitution in key sectors can be very effective.

How useful or efficient has the policy of requiring Country Phase Out Programs been? It is difficult to say conclusively but, from the evidence so far, it appears that the programs have had little impact. As of January 1994, a total of \$3.8 mn has been disbursed for 56 country programmes, at an average cost of \$64,000 per country. As the Multilateral Fund's own Report on the Operation of the Financial Mechanism states, projects may be developed by the countries concerned, by implementing agencies etc., independent of the country program (UNEP, 1993). The Secretariat for the Multilateral Fund has concluded, correctly, that tying all phaseout activities to the country program would be unnecessarily restrictive. But there is a strong case for reviewing country programs, perhaps after a 3 or 4 year interval, to establish a better link between the strategies and the actual implementation projects: making full use of the better information arising from the first actual project outcomes as to costs and effectiveness, to revise regulatory and incentive frameworks as well as unit cost estimates, production, consumption and trade data, and phaseout schedules.

²The Thailand study is an exception to the early phaseout being less costly.

Table 3.1
Costs of Country Strategies for the Phase-out of ODSs: 1991-2010

Country	Egypt	India	Thailand	Tunisia
ODS Phased Out Tons/	72,495	653,804	605,000	413,000
Incremental Cost \$/Ton "Typical Scenario"	1,796	804	321	1,189
Incremental Cost \$/Ton "optimum Scenario"	928	428	971	618
Discount Rate(%)	10	8	5	10
Comments	Optimum scenario has phase out. Costs include all indirect costs such as for awareness etc.	Typical scenario assumes early action. With delayed action costs are more than double. Optimum scenario has maximum recycling	Optimum scenario involves a delay in action. Recommend: a faster phase out scenario.	Optimum scenario involves a faster shift to non-CFC refrigerators.

1/ This is the amount of ODSs that would be used under the unconstrained demand in the absence of a Protocol

Sources: See text.

There is also some evidence that the material from the country programmes is not being widely circulated to the implementing agencies. When they come to prepare a project, they are consequently repeating some of the data gathering and analysis that was done as part of the country program. A case in Egypt was cited to the Economics Options Committee where UNDP, in preparing its projects in the country was duplicating much of the work carried out by the World Bank in the country program.

While a poor country program has little value, a good one can be a major contributor to an efficient strategy, as the World Bank's case studies reveal. From what can be observed, however, this has not been fully exploited and the present country programmes have not added as much as they might to the overall goal of phasing out ODSs. It is therefore recommended that the country programs be re-examined and reviewed, after a suitable (3 or 4 year) interval, to make them more relevant to cost-efficient phaseout strategies.

III. MEASURES OF EFFICIENCY IN IMPLEMENTING ODS PHASEOUT

In the final analysis, of course, one should look at how effective the institutions responsible for phasing out ODSs have been. Where actual data on phaseout are available, it should be possible to estimate the costs per ton of ODSs removed. Wide variations in such costs could indicate relative inefficiency. One should also look at the administrative costs as a percentage of the costs of the investment programs themselves. The Secretariat of the Multilateral Fund prepared an interim report in February 1994 (UNEP, 1994) showing what had been achieved from the time formal operations began in January 1991 up to the end of 1993.

(a) Over 400 activities in 56 Article 5(1) countries have been approved, as well as 43 global activities

(b) 328 investment and demonstration projects (i.e. those costing less than \$500,000) have been approved at a total cost of \$121.8 millions. These were expected to result in a reduction of 115,000 tons of ODS, representing a cost of \$1060/ton removed.³

(c) Actual disbursements, however are picking up more slowly. In the first two years (1991-1992), UNEP-managed activities had spent \$1.8 mn, UNDP \$1.3 mn, and the World Bank \$3.3mn (No figure was given for UNIDO). At that stage (i.e. end 1992) the total amount approved and allocated to the agencies was nearly \$50 mn. Thus disbursements were only 12% of the amounts allocated to the implementing agencies, and by far the largest amounts approved were still to be disbursed. (UNEP, 1993)

³The calculation of cost per ton cannot be compared directly with Table 1 figures because the former represents the annual consumption, whereas the latter is based on total ODS use over the planning period that is eliminated. The report does not say how long the annual use would have continued.

Performance improved considerably during 1993 and 1994. Table 3.2 gives the amounts disbursed by the four implementing agencies (UNDP, UNIDO, the World Bank and UNEP) in 1993. It also gives the proposed expenditures for 1994. There are significant increases in allocations from 1993 to 1994: UNIDO (38%), UNDP (94%), World Bank (78%) and UNEP (89%).⁴

Table 3.2

**Allocations and Disbursements of Funds by Implementing Agencies
1993-1994**

Agency	1993			1994 (Proposed)	
	ODS Removed (Tons)	Funds Allocated (\$mn.)	Funds Disbursed (\$mn.)	ODS Removed	Funds Allocated (\$ mn.)
UNIDO	n.a.	6.9	0.8	n.a.	
UNDP	1424	23.1	9.8	n.a.	44.7
World Bank	n.a.	45.3	19.3	n.a.	80.6
UNEP	n.app.	1.8(?)	1.8	n.app	3.4

n.a. not available

n.app. not applicable

Source: Progress Reports and Work Programmes from Implementing Agencies, UNEP, 1994 b.

It should be noted that the figures for 1994 are provisional and have not been fully approved.

The rates of disbursement are also increasing for the main implementing agencies. In 1992 UNDP spent only 9% of its allocation and the World Bank spent 8.6%. In 1993 the comparable figures were 42% for both agencies.

⁴It is noteworthy that the World Bank nor UNIDO attempt to calculate the ODSs eliminated. This is a useful indicator of efficiency and it would be desirable if the data were to be collected for it.

In terms of administrative costs, UNIDO and UNDP work to a charge rate of 13% of the budget as overhead costs. From the 1994 budget proposal UNEP has a figure of 11.5% for the overhead costs. The World Bank makes no charge to the Multilateral Fund for administrative costs: hence comparable figures are not available from all of the implementing agencies, an issue that has been raised by the Secretariat of the Multilateral Fund. Comparable costs are needed from the Bank if the costs of operations are to be monitored on a consistent basis for all the implementing agencies.

Given that the Multilateral Fund's own administrative costs have to be added to those of the implementing agencies, and these run at about 7-8% of total disbursements by the Fund, one is arriving at a total administrative cost of around 20%, which is considerable. It is important therefore for the Fund and the agencies to try and reduce costs as much as possible, for example by improving coordination and avoiding duplication. These two issues are discussed further below.

A. Coordination and Duplication in the Work of the Implementing Agencies and the Multilateral Fund.

All parties involved in the management of Montreal Protocol activities in Article 5(1) countries are aware of the costs arising from the lack of coordination among the implementing agencies themselves and between these agencies and the Fund. In its Report on the Operation of the Financial Mechanism Since January 1991, the Executive Committee of the Multilateral Fund notes that such concerns have been voiced and that, as a result, the work programmes of the different agencies should be integrated into one document with the Secretariat of the Multilateral Fund playing a leading role in developing such a document. The Secretariat has done that, and it is a positive step but the issue will not be resolved so easily. There are several examples of two agencies doing the same thing in the same place. The case of Egypt and duplication between the country program and the UNDP funded program has already been cited. In Brazil there were two workshops on ODS substitution in the foam sector -- one organized by UNIDO and one by UNDP. Another example, noted by the Multilateral Fund Secretariat is that of the preparation of a computerized monitoring system. One is being prepared by UNDP/UNIDO and the other by the World Bank. If the two are developed it will only create more confusion as inconsistent reporting will result.

Because the ultimate responsibility for the overall program lies with the Executive Committee, it should ensure that the programmes it approves do not allow for the possibility for duplication of effort. In this regard it is not enough to publish a work program that consists of simply combining the separate work programmes of the four agencies that have been approved. The approval process needs to take account of the potential for duplication.

A special case of duplication of effort is with regard to the appraisal of investment projects. At present the World Bank has an "Ozone Operations Resources Group" (OORG) that reviews all projects in a rigorous way. The Multilateral Fund, however, also uses the UNEP Technology and Economic Assessment Panel (TEAP) to evaluate the same projects. The World Bank needs its projects to be properly appraised and for this purpose draws on a wide range of consultants. Whether these are called the Ozone Operations Resources Group or simply Bank consultants is not important. The World Bank also calls on TEAP members,

when appropriate, as consultants. However, what is a matter of concern is that simple projects are being scrutinised both by the World Bank and the Multilateral Fund, thus at least potentially duplicating effort and misallocating resources.

In some cases the issue is not one of duplication but of coordinating the activities of the different agencies to ensure that each component works satisfactorily. If UNDP is to do demonstration projects for a certain sector it would be helpful if a workshop on that sector had been organized before by UNEP. Or if a World Bank project has a major recycling component, the capacity to monitor and administer that component should be in place. In the documentation available to the Economic Options Committee, there is little evidence of such coordination.

Not surprisingly, the larger, better organized companies are able to draw on the funds whereas the smaller producers/users cannot prepare the relevant documentation to satisfy the World Bank documentation needs. This may have implications for industrial competition inside the countries. Equally unsurprising is the fact that the recycling activities, which are shown to be so important from the least cost strategy, are among the slowest to get off the ground.

B. Efficiency and Administration Costs

It was noted that the administration costs of the whole operation are significant. The administrative procedures are also time consuming, thus slowing down the disbursement of funds. Simplifying procedures can help reduce both the time taken and the cost of administration. Again the parties involved are aware of this and are taking steps to improve matters. For example, the World Bank, found that its normal procedures for appraising, implementing and supervising projects were not suitable for this area of activity, which involves a number of small projects and a many different enterprises. At the Tenth Meeting of the Executive Committee of the Multilateral Fund (28 June/1st July 1994) it acknowledged that disbursements to date had been small, but that there were real prospects for improvement. One change that it is making is to modify the procedures for a grant agreement between the borrowing country and the World Bank, making an "umbrella agreement" wherever possible. Once this has been put in place future legal procedures should be minimized. Such an agreement has been signed in Brazil and others are being planned. The Bank is also trying to reduce costs by putting a number of projects into one "umbrella project" as well as making other procedural simplifications. The results are now emerging. Whereas in 1991 it took the Bank over 16 months to complete a grant agreement, it only took 10 months for those projects that were approved in January 1994. Although there are merits in such simplification procedures, they can result in monitoring problems. The Multilateral Fund Secretariat needs to know what the status of each project is -- completion of contract, initiation of construction, project commissioning, etc. The World Bank "umbrella" approach makes that difficult to provide. However, some compromise between detailed monitoring and simplification of procedures should be possible.

The Secretariat of the Fund might also be able to simplify its administrative procedures further, without impairing project quality. Many of the projects fall into broad categories, within which the various projects are very similar. If reputable agencies such as UNDP, UNIDO and the World Bank have reviewed them and approved them, is it necessary to have

another detailed review? Perhaps a checklist could be developed, which would apply to all projects, with only a sample being subjected to a detailed review. The World Bank has compiled a list of "benchmark unit abatement costs" which provides a wide range of cases of ODS substitution, with quantitative information on capital and operating costs, ODS substituted, and incremental cost. Could these not be reviewed (added to, if necessary) and used more widely in appraising projects?

C. Measures of Efficiency of Operation.

Efficiency in the operation of each implementing agency is very hard to estimate. It is most difficult for technical assistance agencies such as UNEP and UNDP. UNEP is involved in a large number of activities, including the Ozone Action Information Clearinghouse (OAIC), aimed at institutional strengthening and information exchange as well as other activities such as training, networking and preparation of country programs. It has instituted feedback procedures in relation to these activities but, as of February 1994, the results of these were not available. In 1993 the OAIC program had a budget of \$1.58 million, which accounted for 88% of the UNEP budget for ODS phaseout programs⁵.

Clearly it would be desirable to have some measures of the effectiveness of this expenditure. It is not enough to report the number of meeting held or modules of information delivered, useful though such information can be. At the same time one cannot measure the direct contribution to the removal of ODSs. It is difficult to separate out the contribution of OAIC from that of other activities, which have a more direct bearing on ODS removal.⁶

The only way immediately available for collecting the relevant information on the effectiveness of the networking and training programmes is to carry out a detailed evaluations including asking participants for their assessments of the services provided and what use they have made of them. Some such surveys have been attempted. In 1992 the representatives from Canada, Australia and New Zealand responsible for the Interim Fund's operations, undertook a survey in Brazil, Colombia, Ecuador, Ghana, China, Malaysia, Philippines, Sri Lanka and Egypt. They asked participants from these countries involved in the ODS phaseout process about "the quality and appropriateness of technical information provided, the quality

⁵In some respects the networking and information exchange activities are similar to those associated with the launch of a new product, where consumers needs to be informed about the product and its characteristics. Ways in which such programmes are assessed could be a useful pointer for these activities in the ODS phaseout program. From the comparison, one would expect that the budgets for information would rise in the early years and then decline over time. This does not, however, appear to be happening as far as the OAIC is concerned.

⁶One suggestion that has been made is to estimate a "production function", in which the "output" is ODS removal, by sector and region, and the inputs are investment activities, information activities, training activities etc, generally measures in money terms. By using econometric techniques it may be possible to ascertain what the marginal contribution of each of the activities to ODS removal has been. But it would not provide a detailed evaluation of the different components of the networking and training programmes.

of the international expertise made available to them and the usefulness of the assistance received at different stages in the program" (UNEP, October, 1992).

The main findings are that:

- (a) on the technical information provided all respondents rated the it as of very high quality and that is distributed in a timely fashion. One or two respondents noted that the experts were not as knowledgeable of local conditions as they might have been;
- (b) the training received was highly praised as relevant and well presented; and
- (c) the technical and financial assistance received was generally considered to be satisfactory.

The main criticisms were that:

- (a) there was not enough effort to increase local capacity. The lack of support for institutional strengthening was particularly commented on; and
- (b) the investment programmes were regarded by some respondents as being too slow and too bureaucratic.

Similarly, in 1994, management consultants Touche Ross reviewed the UNEP/SIDA network program on ODSs in South East Asia (Touche Ross, 1994). The program involved the creation of a network of government ODS officers who would be trained in designing and implementing effective phaseout strategies. This attempt at institution building seems to have been very successful, if measured in terms of the views of the participants. Touche Ross propose the use of a measure based on expenditures on training divided by the total ODS output to be phased out in the region. At least this would indicate when one region was receiving a disproportionate share of the training resources.

It appears that this kind of review is essential to the design of an efficient phaseout strategy. The following performance criteria could be derived for the agencies involved in training, networking and information dissemination:

UNEP: Summary statistics from feedback surveys for each of its activities: information exchange (number of contacts made, response from the contacts, views of users); and training (participants feedback, both immediately after the workshops and 6 months after, to see how useful the information has been).

UNDP/UNIDO: Post project appraisals should be carried out for institutional strengthening (to see whether they achieved what they set out to achieve). Where specific technical assistance is provided reports on its usefulness and effectiveness can be made in a similar manner.

For implementing agencies involved in investments, it is important to estimate the amount of current ODS eliminated and the cost per ton eliminated. There are some summary statistics of this kind but they are not regular, consistent and are not available for all agencies. The Executive Committee of the Multilateral Fund should consider instructing the implementing agencies to collect such information. This also implies a need for the Multilateral Fund to consider how best to review and evaluate project implementation in order to confirm from actual experience the least-cost methods of ODS replacement. It would be useful if the Secretariat prepared a note indicating how data should be reported, how it should be calculated and with what frequency it should be reported. This would ensure consistency and provide a basis for estimating the efficiency of different organizations.

Finally, the Secretariat should carry out a review of the program in each country every 3-5 years, to see how the country program has been implemented, what slippages there have been and how effective the different components of the program have been.

In all this, there is clearly a need to balance the monitoring requirements against the imperative to keep administrative costs low. At the present time, however, there is very little to go on in terms of overall efficiency measures for the implementing agencies. At the same time, the Multilateral Fund feels that it should not be judged by cost effectiveness alone and has argued that account should also be taken of the "benefits". It is understandable that the Fund has to operate within political constraints and so cannot, for example, allocate resources only to those countries with the lowest cost of abatement. At least part of the high administrative cost reflects the political need to provide some equity in the disbursement of funds and assistance. However, that does not mean that information on the cost effectiveness of the funds is not important or useful. Where the reasons for low effectiveness are those identified above this should be made clear, so that the Parties can see the price they are paying for the political dimension. As to the possibility of taking account of "benefits" this does not appear to lend itself to measurement. There are benefits in the sense that ODSs are phased out, but the Protocol has never attempted to estimate them in a benefit cost framework and it would not be desirable to attempt that now. If by "benefits" is meant that the political benefits, or benefits in terms of having an international accord, these are not quantifiable. It may be possible, for example, to estimate a minimum cost of removing a given amount of ODSs, subject to the constraint that each country received a minimum amount of the Multilateral Fund's disbursements. The actual cost per ton removed could be compared with that. Such an exercise might be useful in directing resources and in assessing where improvements might be made in future allocations.

IV. ALTERNATIVE INSTITUTIONAL ARRANGEMENTS.

In assessing the efficiency of the current arrangements for ODS phaseout, it is important to note that substantial work is currently (September 1994) in hand or about to begin to review the operation of the institutions established for the purpose. These reviews include a study of the operations of the Multilateral Fund, commissioned by the Executive Committee on behalf of the Parties; and an internal review - which will be widely distributed - by the World Bank of its operations for ODS replacement in the first years of the Montreal Fund's operations. The Terms of Reference of the former appear at Annex A to this chapter.

Within the wider scope of these reviews, it would be useful to address two sets of issues in the common interest of quicker and less costly project approval procedures. The first set is to review

- (1) the respective roles of the UNEP TEAP and of the World Bank's OORG and the scope for their closer coordination;
- (2) the scope for increased reliance on the appraisal procedures and judgement of the implementing agencies, supported by the advice of a common external experts panel; and
- (3) whether the Multilateral Fund Secretariat meet its responsibilities by relying on a checklist approach based on benchmark costs for and proven procedures for dealing with generic projects.

The second set of questions concerns the possibility of establishing closer coordination between the Secretariats of the Multilateral Fund and the Global Environment Fund in facilitating ODS phaseouts in the Article 5(1) countries and "in the countries in transition to market economies", respectively. Given that they will deal with similar projects, there might be scope for resource savings and efficiency gains through closer coordination. It is recognized that enhanced coordination would have to be reconciled with the different constituencies and voting structures of the two Funds.

V. CONCLUSIONS.

Given the large amount of resources involved, the efficiency aspects of the implementation of the Montreal Protocol are important and need to be addressed. In this Chapter the framework used for designing phaseout strategies has been examined.

One of the key components of the strategy is the preparation of the country program, which is supposed to ensure cost effectiveness and as well as efficiency in the phaseout process. However, from this review the country programs do not appear to have played a major role. The ones approved have very wide differences in phaseout costs per ton of ODS removed. The World Bank has carried out a limited number of case studies of phaseout strategies which show a much narrower range of phaseout costs and are suggest lessons for developing cost efficient strategies. This review of the evidence on the economic efficiency of the implementation process in Article 5(1) countries suggests that all country programs should be reviewed at 3 or 4 year intervals. Such reviews could make use of the evidence of generated by actual project implementation to update and improve (1) production, consumption and trade information, (2) regulatory and incentive frameworks, (3) and phaseout strategies.

The Chapter has also looked at the activities of the implementing agencies. The first two years of their programmes (1991-1992) were very slow in terms of actual disbursements, but performance has picked up considerably in the last 21 months. Disbursements as a percentage of substantially increased allocations went up from 12% in 1991-92 to 42%.

The administrative costs remain a matter of concern, although they are expected to fall in relation to actual project expenditures as implementation accelerates. For UNEP, UNIDO, UNDP, and the World Bank they currently range between 11% and 29%. If the Secretariat costs are added, they average 35% of total expenditures, which is high. They should be reduced if it is possible to do so impairing the quality of the project approval process. However, the justification for the costs incurred is expected to be found in the sharp decline of the administrative cost ratio as the implementation of approved projects and new project approvals accelerate with the progress of the implementation process up its learning curve.

The efficiency of the different agencies needs to be monitored. For those involved with training, networking and institutional strengthening, there is a need to carry out independent surveys of the programmes, especially asking the participants and users of the services for their assessments of the services provided. The initial evidence is positive but much more evaluation work needs to be done.

One suggestion is that a "production function" approach could be taken to the ODS phaseout experience with the different activities being treated as inputs. Econometric techniques might be useful in estimating the marginal benefits of the different inputs.

The estimated costs of phaseouts vary enormously among countries. Further investigation of these differences would be instructive and might yield information of value in the effort to improve country programs for ODS phaseouts.

For investment projects, estimates of ODSs phased out should be provided using a consistent methodology set out by the Secretariat of the Multilateral Fund. These figures should be reviewed to determine their implications for future project approvals. It is recognized, however, that the Multilateral Fund cannot be guided by efficiency considerations alone, but that is not a valid argument for minimizing the monitoring of cost efficiency.

Finally, two institutional issues are raised. First, there is the coordination of effort between the World Bank's Ozone Operations Resources Group and UNEP's Technology and Economic Assessment Panel. There may be scope for rationalization. Second, there is the question of whether the Multilateral Fund and the Global Environmental Fund (GEF) should be more closely coordinated.

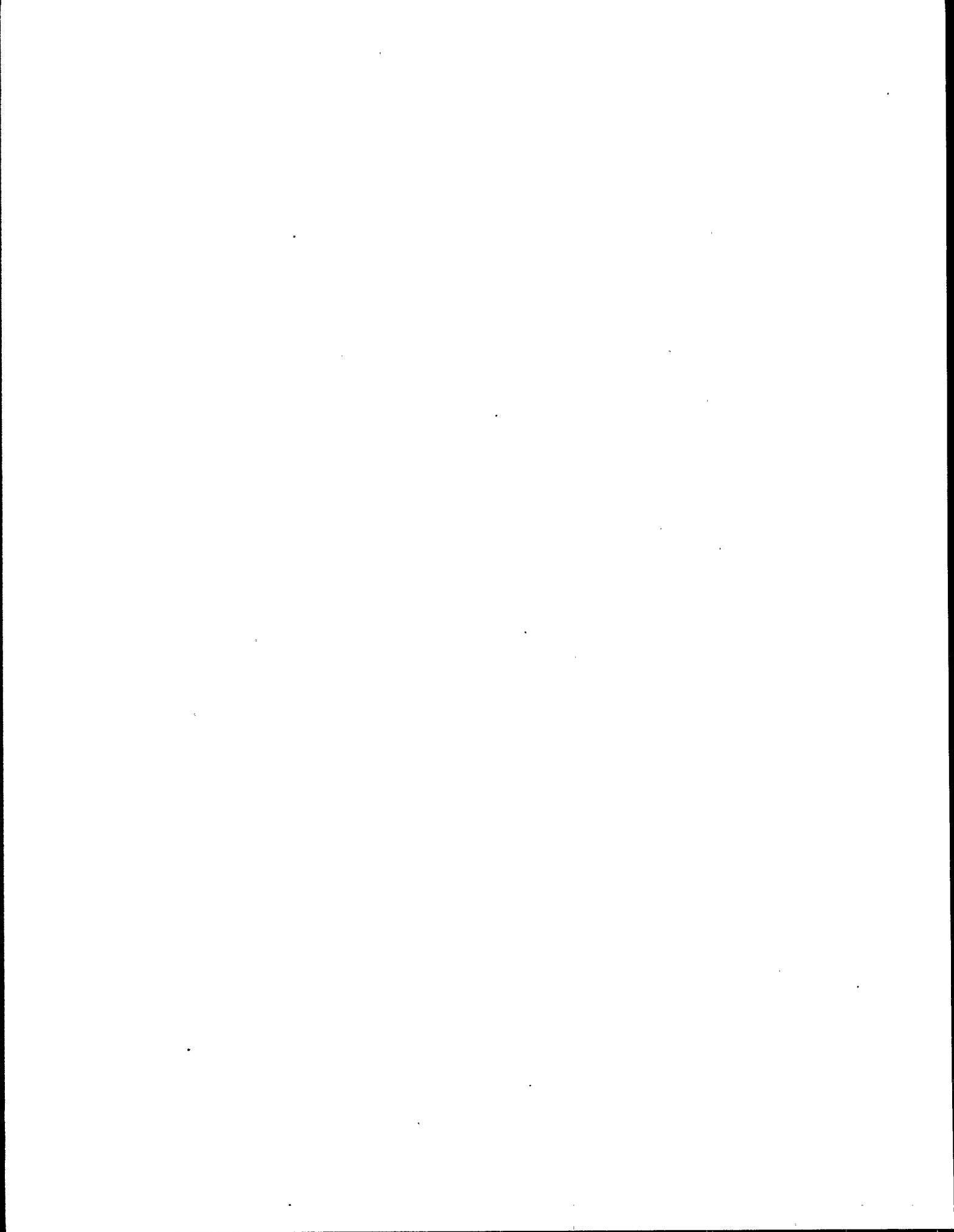
Annex A

1. Review under Article 5, para 8 of the Protocol

A meeting of the Parties shall review, no later than 1995, the situation of the Parties operating under paragraph 1 of this Article, including the effective implementation of financial co-operation and transfer of technology to them, and adopt such revisions that may be deemed necessary regarding the schedule of control measures applicable to those Parties.

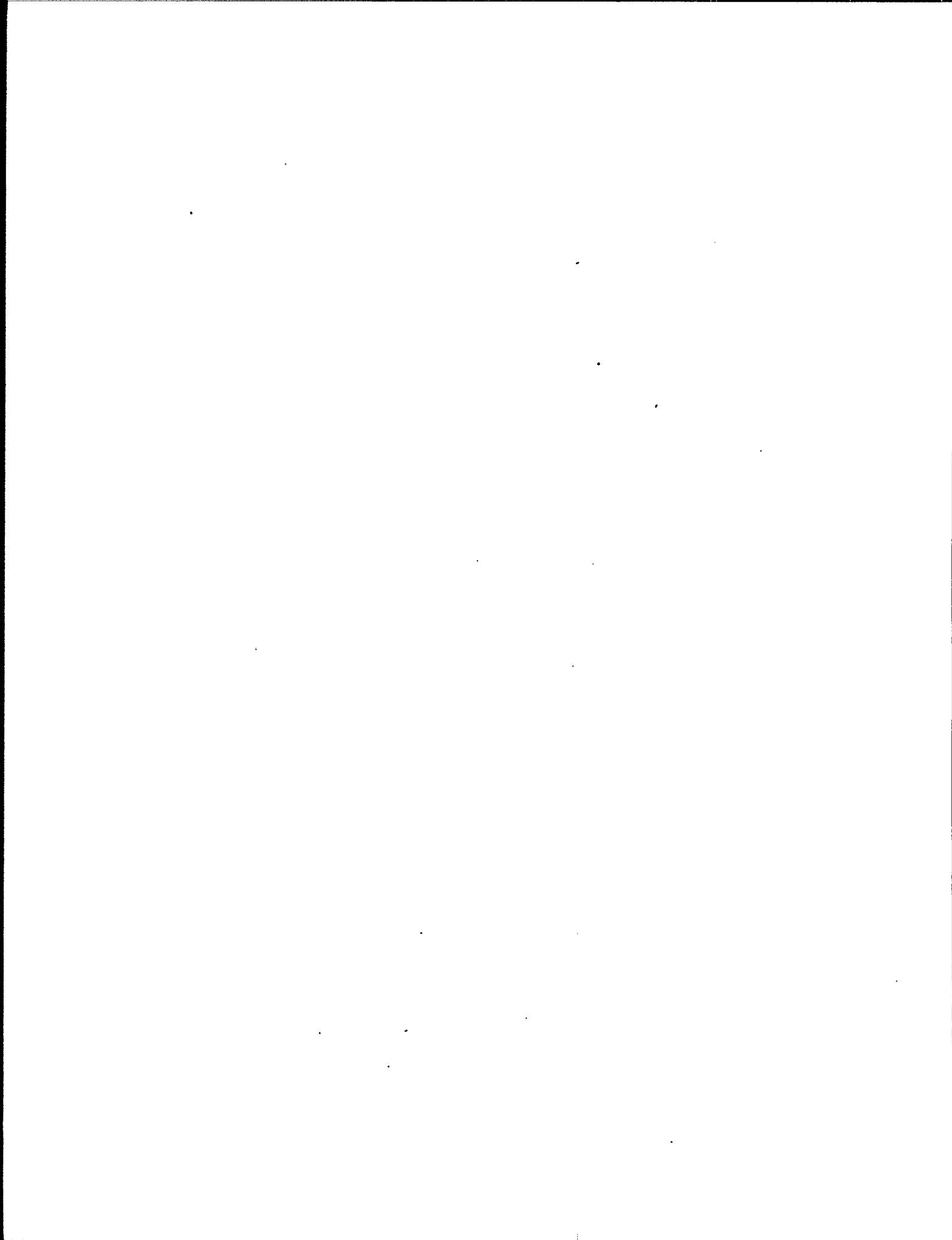
2. Review under Decision IV/18 of the Parties, section II para 4

To evaluate and review, by 1995, the Financial Mechanism established by Article 10 of the Protocol and Section I of the present Decision, with a view to ensuring its continued effectiveness, taking into account Chapters 9, 33 and 34, and all other relevant Chapters, of Agenda 21 as adopted by UNCED in Rio in 1992.



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CHAPTER 4

POLICY REGIMES FOR PHASEOUT OF OZONE DEPLETING SUBSTANCES

I. ELEMENTS OF THE POLICY FRAMEWORK

Governments must bear ultimate responsibility for ensuring that their countries comply with commitments made in signing the Montreal Protocol. Above all, this means adhering to the agreed timetable for phaseout of different categories of ozone depleting substances (ODS) and reporting to the Parties on progress in meeting phaseout requirements. This chapter discusses elements of the policy regime which individual countries need to put in place if ODS phaseout is to occur in a timely and cost effective manner. There is no single policy regime suitable to all countries. Yet, there are certain elements common to many of the regimes already in place in both developed countries and Article 5(1) countries. Those elements can be broadly grouped into three categories:

- o command and control measures, involving the establishment of a statutory and regulatory framework which penalises non-compliance;
- o market mechanisms, or economic instruments, which provide financial incentives to encourage compliance;
- o voluntary approaches, which may include measures to raise public awareness and alter consumer preferences, or agreements negotiated between government and the private sector specifying agreed measures to reduce ODS consumption and production.

These categories are not mutually exclusive. In practice, policy regimes normally combine more than one - e.g., relying on voluntary agreements with certain large ODS suppliers or users to achieve initial reductions while a legal and regulatory framework is being constructed for broader application. Moreover, in those Article 5(1) countries which make use of the resources of the Multilateral Fund, financial incentives for ODS reduction are an integral part of the policy framework. Each government must decide on the appropriate mix of policy instruments given its own legislative and fiscal culture, local industry circumstances, the speed at which ODS phaseout is to be achieved, feasibility of enforcement and cost-effectiveness.

For the government to be able to design a policy regime suited to its own national circumstances, it needs to have a clear picture of the characteristics of the local ODS supplier and user industries. The country study normally undertaken in preparation of a national ODS strategy should provide valuable information which can inform policy formulation, including baseline estimates of production and consumption of controlled substances by sector. Among the questions such a study should seek to answer are the following:

- What quantities of different controlled substances are being produced or imported, and by whom?

- In which sectors and by which firms are those substances being used? Is use highly concentrated sectorally and/or within specific enterprises?
- Are the major ODS users foreign or local firms? Do they have ready access to alternative technologies? Have any firms already switched to alternatives?
- Are ODS users exporting products containing these chemicals? If so, where?

The policy approach chosen may be very different depending on answers to these and other questions. For instance, if a high percentage of ODS use is accounted for by a handful of aerosol product manufacturers, a ban on ODS use in non-essential aerosol applications, together with a targeted program of technical assistance to those firms, could be the main focus of an effective policy response. If, however, ODS use is widely dispersed among many small firms operating in different sectors, a subtler and more variegated approach may be required. Given the difficulties of monitoring large numbers of small, widely dispersed ODS users, command-and-control measures alone may be difficult to enforce. Thus, governments may need to combine them with economic instruments, awareness raising, and perhaps broad-based technical assistance and training programs (e.g., for mobile air conditioning mechanics or industrial chiller maintenance personnel).

The *process* of policy formulation can have a major bearing on the degree of acceptance and compliance by supplier and user industries. In particular, experience suggests that close consultation with industry and involvement of industry groups in the design of the phaseout strategy increases the probability of willing co-operation during the implementation phase. In Norway, for example, a CFC-users committee was established in 1988; it organises annual seminars for information exchange between the government and industry. The Norwegian government attributes its success in achieving an accelerated ODS phaseout in large measure to the high degree of industry involvement in policy formulation.

Malaysia is another country where industry has been deeply involved in strategy and policy formulation from the outset. Six working groups were formed covering the major user sectors; they have been instrumental in providing inputs into formulation of specific sectoral elements of a national strategy. In a number of sectors (e.g., aerosols, fire extinguishers and foams), the working groups proposed accelerated phaseout schedules, which have been incorporated in the national strategy.

A. Monitoring and Reporting of ODS Production and Consumption

Irrespective of the weight given to different categories of policy instruments, any policy regime must be based on sound information on ODS production and consumption (defined as production less exports plus imports less destruction with approved technologies). Tracking the quantities of different controlled substances which are being produced, imported, and exported requires a system of registration and recording of ODS transactions. For those many Article 5(1) countries which are dependent exclusively on imports to satisfy their ODS demand, the logical focus for monitoring ODS shipments is at the border - through customs declaration.

The code used for customs declaration in most countries is based on the Harmonized Commodity Description and Coding System (HS), which describes chemicals according to their function rather than their chemical properties. Thus, to keep track of trade in controlled substances, a modification to the customs code is usually required. The Customs Cooperation Council (CCC) established for the purpose has recommended the addition of new sub-headings to the national statistical nomenclature for the purpose of monitoring ozone depleting substances. The modified HS tariff codes contain a separate number for each controlled substance. Customs authorities need to record shipments using this nomenclature and then transfer that information to the government agency responsible for ODS monitoring. The process of recording ODS imports can be complicated by such factors as mis-reporting by importers (especially once import controls have been introduced) and mis-recording by customs authorities (possibly because substances are imported in blends under unfamiliar brand names).

Even though Article 5(1) countries have a grace period before they must begin their actual phaseout, monitoring and reporting of ODS production and consumption should begin as soon as possible after a country becomes a Party to the Protocol. Within three months of becoming a Party, the government must report baseline production, import, and export data for controlled substances to the Ozone Secretariat. Moreover, most Article 5(1) countries will choose to begin their phaseout of ODS long before the end of the 10-year grace period. To be able to gauge the effectiveness of the phaseout effort, they will therefore need to put in place a system for collecting reliable data on ODS shipments. Data on ODS production and consumption is also needed to support requests for assistance from the Multilateral Fund.

While customs data play a critical role in an effective monitoring system, they can be supplemented by and cross-checked against data from other sources. Moreover, for historical consumption it may be difficult to reconstruct estimates from customs data which at the time were not collected in accordance with the relevant classifications. Thus, other sources may be needed to provide baseline estimates to the Ozone Secretariat, the two most common being ODS suppliers and ODS users. Since the number of ODS importers/suppliers is generally much smaller than the number of ODS users, a survey of suppliers can be a cost-effective means of obtaining consumption data. Where ODS use is highly concentrated among a small number of firms, requiring those ODS users to report their consumption to the government can also yield useful information on approximate overall consumption levels. If, however, the number of ODS users is large, a comprehensive user survey becomes more difficult and costly. For surveying user industries, a more cost effective approach may be to work with chambers of commerce or industry associations, which maintain regular contact with their members.

B. Permitting and Licensing of Controlled Substances

Once a customs data collection system is in place, it should facilitate the introduction of quantitative controls on ODS imports, which for countries without their own production capacity are likely to be the principal feature of a regulatory regime. Many countries now require that all firms intending to import ODS register with a designated government ministry/agency and apply for an import permit. Normally the volume of ODS a firm is permitted to import is pro rated based on its recent import levels, though there are other ways

by which the permits can be allocated - for example, through an auction or tender (discussed below). With a permit system, the government is in a position to regulate the overall supply of ODS in the country. Initially it may simply choose to freeze the total volume of imports or limit them to some target growth rate. Eventually, as the phaseout proceeds, the volume of permitted imports can be reduced according to schedule, with the diminished supply still allocated as before. The permit or license to import ODS may be subject to conditions, e.g., specifying the applications for which specific controlled substances may be used, reporting requirements, etc.

One example of an import permit system is that of New Zealand. Import permits are granted in relation to the applicants' 1986 use of ODS (or in the case of 1,1,1-trichloroethane and carbon tetrachloride, 1989 usage), but those permits can be sold or transferred to other users. Imports of ODS are recorded initially by the Customs Department at the wharf using the modified HS system tariff codes and then the data is passed on to the Statistics Department where it is entered into the computer database before being passed on to Ministry of Environment. When deemed necessary, the Ministry cross-checks the figures by requesting the three major importers to supply information on their own imports as well as estimates of the total market.

II. COMMAND-AND-CONTROL MEASURES

Many countries already possess legislation dealing with the control of environmentally hazardous substances. In such cases, it is usually possible to utilise existing statutes to justify control measures for ozone depleting substances. In the case of the United States, the Clean Air Act, as amended in 1990, provides authority for implementing regulations to control ODS. In the case of Thailand, CFCs and halons have been added to the list of chemicals subject to regulation under the country's Hazardous Substances Act of 1992. Since passage of legislation can be a time-consuming process, where it is not already on the books an interim solution may be the issuance of an administrative order which provides government with the authority to take ODS control measures.

A. The Phaseout Schedule

The most basic decision governments must make regards the phaseout schedule to adopt. The issue of timing and its implications for costs of phaseout is discussed elsewhere in this report (see Chapter 3). The principal requirement is that the chosen phaseout schedule conforms to requirements of Parties to the Protocol. Beyond that, a country has the option to accelerate the phaseout and several Article 5(1) countries have chosen to do so. Various reasons have been invoked for accelerated phaseout, including: (a) the rising costs of waiting as ODS supplies become scarcer and more expensive; (b) preempting the expansion of the stock of refrigeration and other equipment dependent on ODS; (c) the need to maintain access to export markets which are becoming more restricted to ODS containing products. Against these considerations a government must weigh the feasibility of achieving an accelerated phaseout and the possible damage to the credibility of the phaseout effort of announcing a schedule which is overly ambitious. Governments may choose to adopt different phaseout schedules for different user sectors in recognition of varying technical and economic feasibility.

A calculation for Ghana of the cost implications of an accelerated phaseout suggests scope for sizeable cost savings, deriving largely from the avoidance of the build-up of an ODS-using stock of refrigeration and other equipment which would then need to be scrapped prematurely. The total incremental costs of phaseout are estimated to be some three-and-a-half times higher in the case of a phaseout according to the Protocol timetable than in the case of an accelerated phaseout.

B. Quantitative Restrictions

Commitment of government to a certain phaseout schedule implies commitment - at least as a last resort - to enforcing quantitative restrictions (or quotas) on ODS supply. Assuming effective enforcement, there should be little uncertainty about a country's ability to meet its obligations under the Montreal Protocol. Indeed, one of the principal attractions of an ODS quota system is the predictability of outcomes. Effective enforcement remains, however, a formidable challenge in many Article 5(1) countries. Another important consideration is the method of allocating the (constrained) supply of ODS among importers/users. A strict pro rated allocation (without the possibility of trading or other means of eliciting firms' willingness to pay for the right to import/use ODS) can prove a relatively costly way of phasing out ODS. This is because it forces proportional ODS cutbacks by all firms even though some may be able to achieve reductions at substantially lower marginal cost than others. It could be argued that, given the expected environmental benefits of ensuring ODS phaseout according to schedule, the additional costs should not weigh heavily in governments' decisions about instrument choice. Fortunately, even with a system based on quantitative restrictions, it is normally possible to build in a degree of flexibility so as to reduce the phaseout costs. Moreover, once the government imposes quantitative restrictions, in the short-run the resulting scarcity is likely to create opportunities for importers to reap windfall profits from their control over ODS supply. Thus, measures may also be needed to reallocate those profits. There are economic instruments which can serve this purpose as well (see next section).

C. Prohibition of Specific Uses and of Production

Besides quota restrictions, there are other CAC measures governments may choose to use. Perhaps the most familiar are outright bans of ODS in specific uses -- e.g., CFCs in non-medical aerosols or rigid foams, and halons in new installations. Such bans are most easily enforced where alternatives not only exist but have been proven cost-effective. In some cases, countries have imposed bans on imports of products containing ODS. Where domestic producers of similar products have been required to phase out ODS use, such an import ban may be the only way to ensure that domestically produced ODS-using products are not simply replaced by imports of the same. This could occur if the domestically produced alternative is more costly than the imported ODS-using product. An import ban may also be appropriate when a product could be expected to generate replacement demand for ODS during after-sales servicing -- the clearest instance being mobile air conditioning (MAC). Thus, some countries require that all newly imported automobiles contain non-CFC using air conditioners.

Since Article 5(1) countries not presently producing ODS could still become production bases before their required phaseout, some governments have chosen explicitly to prohibit such production. Thus, an international CFC producing company seeking to export

its production technology to a particular Article 5(1) country would be prevented from doing so. Malaysia, for one, has instituted such a production ban. Similarly, a number of countries have chosen not to issue licenses for investment in new facilities that propose to employ ODS in their production processes or to incorporate them in their products.

The issuance or modification of product or process standards can be another CAC measure aimed at discouraging ODS use. One instance is the US Defense Department's modification of its military specifications to permit the use of alternatives to CFC-113 for solvent cleaning purposes. China has revised design standards for cold stores to promote substitution away from CFC refrigerants. The United States requires certification not only of equipment used in the servicing of motor vehicle air conditioners but also of service technicians.

D. Product Labelling Requirements

Mandatory product labelling is another CAC measure employed in some countries. Under 1990 amendments to the Clean Air Act, the US government requires mandatory labelling of Class I and II substances, and products containing or manufactured with such substances (with a few exceptions). The German Ordinance on the Prohibition of Certain Ozone-Depleting Halogenated Hydrocarbons also contains a labelling requirement for CFC-containing products, including refrigerants, insulating material, and cleansing agents and solvents. (The label must read: "Contains ozone-depleting CFC.") Labelling is likely to prove an effective deterrent to ODS use only when consumers are well-informed of the ozone depletion problem and their product preferences are significantly influenced by environmental concerns. As a positive marketing device, many products now contain labels informing customers that they are "ozone-friendly."

E. Recycling Requirements

Finally, mandatory recovery and recycling of ODS in certain applications may be considered. A ban on the intentional venting of ODS during servicing or disposal of ODS-using equipment is another way of trying to promote recovery -- one used by the United States. Enforcing such a ban may not be easy, since proving intent could be difficult, as could monitoring the large number of small and widely dispersed service shops engaged in automobile or appliance maintenance. Whether the market itself will ensure a high recovery/recycling rate depends to a significant degree on the price of virgin CFCs and halons. As long as there is a plentiful supply of these substances and prices remain low, there is little incentive for firms voluntarily to recycle their ODS. In the event, governments might need to subsidize investments in recycling equipment. In Thailand, for instance, while the government is requiring all MAC service stations with an operating capital above \$40,000 to install recovery and recycling equipment, it is also acquiring low-cost equipment for dissemination to smaller operators. Ghana has applied to the Multilateral Fund for financing of 32 recycling machines to be made available to refrigerator maintenance shops. Mexico has also proposed a demonstration project involving a large, centralised MAC recycling facility in Mexico City and the provision of recycling equipment and training to operators of smaller facilities. (Certain economic instruments may provide an incentive to recycle ODS while at the same time helping to finance the costs, as discussed in the next section.)

Pre-tax prices of the major controlled CFCs (CFC-11, CFC-12, and CFC-113) have been rising steeply in the United States market; combined with the escalation of the excise tax, incentives to CFC recycling and to substitution away from CFCs should be getting noticeably stronger, though the recycling business has been somewhat slow to respond. Meanwhile, there is concern in certain other countries that CFC prices have been rising more slowly than anticipated, thereby incentives to switch to HFCs and HCFCs. However, with an end to CFC production and the depletion of stockpiles in non-Article 5(1) countries, the price picture could change rather quickly in the future.

III. ECONOMIC INSTRUMENTS FOR ODS PHASEOUT

Economic instruments are measures which operate directly on or through markets to influence levels and patterns of supply of and/or demand for ODS. Those instruments potentially applicable to ODS phaseout include: excise taxes on controlled substances; tariffs on imports of ODS or ODS-containing products; tariff concessions on non-ODS using technologies; deposit-refund schemes; tradeable permits and permit auctions. Such instruments are increasingly widely used by Parties to the Protocol, though their use is almost always in conjunction with rather than in place of regulatory (or CAC) measures.

A. Excise Taxes on Ozone Depleting Chemicals

An excise tax on ozone depleting chemicals is a form of pollution charge. It has been used since 1990 in the United States; Denmark also employs an excise tax on ODS and Thailand's country program contains a recommendation for introducing such a tax. The US tax is described here in some detail.

The US excise tax is not the only economic instrument employed as part of its national ODS phaseout program. In addition, it has introduced a system of tradeable ODS permits (or allowances). The ozone-depleting chemical tax was introduced on 1 January 1990 and extended effective 1 January 1991. It is levied on each pound (lb) of ODS at a rate which depends on a particular chemical's ozone depleting potential (ODP). The overall rate structure has been adjusted upward since the tax was first introduced, and each year the per unit tax increases. The tax rates for various controlled substances in 1994 and 1995 are shown in Table 4.1. In 1996 and subsequent years the base tax rate is scheduled to increase by \$0.45 per year.

The US excise tax scheme includes a floor tax on ODS inventories held for eventual sale to deter tax avoidance through stockpiling¹. That tax is equal to the amount by which the excise tax on virgin ODS increases each year. This eliminates the advantage of holding stocks in anticipation of future tax increases. It could, however, discourage suppliers in non-Article 5(1) countries from stockpiling ODS from their last few years' production (1994-95 for major CFCs) to meet future equipment servicing demand. At the same time, there is no

¹Since stockpiling for use is not subject to the floor tax, the tax structure provides an incentive for stockpiling among large users.

TABLE 4.1: EXCISE TAX RATES ON OZONE DEPLETING SUBSTANCES,
UNITED STATES (1994-95)

Controlled substance	1994 Tax	1994 Floor	1995 Tax	1995 Floor
CFC-11	4.35	1.00	5.35	1.00
CFC-12	4.35	1.00	5.35	1.00
CFC-113	3.48	0.80	4.28	0.80
CFC-114	4.35	1.00	5.35	1.00
CFC-115	2.61	0.60	3.21	0.60
HALON-1211	13.05	12.80	16.05	3.00
HALON-1301	43.50	43.25	53.50	10.00
Halon-2402	26.10	25.85	32.10	6.00
Carbon Tetrachloride	4.79	1.10	5.89	1.10
Methyl Chloroform	0.44	0.22	0.54	0.10

SOURCE: US Environmental Protection Agency (EPA), Washington, D.C., 1994.

tax imposed on domestically recycled ODS, which should provide an incentive to invest in recovery and recycling².

While the taxes are generally levied on specific controlled substances, there are also a few application-specific taxes - e.g., for rigid foam, sterilants and inhalers. In the first two applications, the tax rates were lower through 1993, but in 1994 they were rapidly escalated to bring them into line with the overall tax rate on CFC-11, CFC-12, and CFC-114. In the case of inhalers, the tax rate remains at the low 1993 level, reflecting the fact that this is still an essential use for which satisfactory substitutes have yet to be developed.

Another important feature of the US excise tax is that it applies not only to bulk production or imports of the controlled chemicals but also to products made with or containing them. Thus, when a product manufactured abroad with CFCs is imported into the United States, it is subject to tax on the CFC content. This has contributed to an accelerated phaseout within the foreign manufacturing subsidiaries of certain US multinationals (notably in the electronics industry) as well as inducing the parent companies to assist their independent overseas suppliers to phase out their own CFC use (see O'Connor 1991).

The fact that the US ODS tax has been superimposed on a system of quantitative restrictions introduces an element of redundancy. For, either the quantitative restrictions are binding, in which case the tax has no incentive effect, or the tax is so high as to reduce demand below the level permitted by the quantitative restrictions, in which case there is no need for the latter (see Oates 1994).

The excise tax could be viewed as a way of realizing economic efficiency gains over the situation of quantitative restrictions alone, but those gains are already made possible by the fact that ODS allowances are transferable between firms. Thus, a firm for which the costs of marginal reductions in ODS use are high can purchase allowances from a firm able to achieve such reductions at relatively low cost. The tax, then, seems designed primarily to serve a revenue raising function: it enables the government (and by implication the general public) to capture some of the above-normal profits which would otherwise accrue to firms selling the scarce supply of ozone-depleting chemicals.

Most Article 5(1) countries already charge excise duties on a variety of products, so the institutional apparatus to collect such a tax on ODS would not need to be set up from scratch. Assuming that an Article 5(1) country has not yet introduced binding quantitative restrictions on ODS consumption, then an excise tax set at a sufficiently high rate might have the desired incentive effect of dampening ODS demand. Even where quantitative restrictions have already been introduced, an excise tax could provide a convenient source of revenue to help finance government's expenditures on the ODS phaseout effort³. The determination of an appropriate rate is likely to be in part a matter of trial and error. Ideally, the government could utilise estimates of the elasticities of ODS demand as a basis for calculating tax rates,

²In the case of imported ODS the situation is less clear cut: the US Internal Revenue Service (IRS) has suggested that the excise tax applies to all imported product, including recycled.

³In the United States, ODS excise tax revenues have not been explicitly earmarked for this purpose.

but where domestic estimates are not available those from other countries with similar user industry characteristics may provide a rough guide.

B. Duty Exemptions and Investment Subsidies

Many Article 5(1) countries charge duties on imports of capital equipment and consumer durables. The level of such duties can vary quite widely from one country to another. In general, however, their effect is to dampen import demand -- the higher the duty the greater the dampening effect. Normally, duties do not discriminate between different environmental properties of equipment in a given category -- say, between CFC-containing and non-CFC-containing refrigerator compressors, or between automobiles with CFC-using air conditioners and those without. Tariff differentiation based on whether a product contains ODS or not may be one way of encouraging a switchover to non-ODS-using equipment. (Similarly, where bulk chemicals are subject to import duties, tariff preferences for non-ozone-depleting chemicals could encourage a faster switchover.) As average tariff levels decline with trade liberalisation in many Article 5(1) countries, the incentive effect attainable through differential tariff rates diminishes. Moreover, the attractiveness of offering preferential tariff treatment to non-ODS-using equipment depends in part on whether the country is itself a potential manufacturer of such equipment. If so, import duty reduction may conflict with another policy objective, namely, to offer transitional protection to domestic manufacturers as they convert from production of ODS-using to non-ODS-using equipment (e.g., refrigerator compressors). Malaysia currently waives the normal duty on technology imports in the case of ODS recycling equipment. Similarly, Ghana offers duty exemptions on ODS-free technologies and ODS recovery and recycling technologies. The Thai government has reduced the duty on imports of ODS recycling equipment from 30 per cent to 10 per cent, but this is part of a broader tariff reduction on capital equipment.

Investment subsidies are another type of economic instrument used to encourage a change over to non-ODS-using technologies. These often take the form of tax incentives. Malaysia, for example, grants a deduction from corporate tax for investment in new manufacturing capacity using non-ODS technology. Likewise in Singapore, firms investing in ODS-reducing technologies can deduct up to 50 per cent of equipment cost from taxable income as compared with only 30 per cent for other types of equipment investment. Small firms can qualify for an additional incentive in the form of a 50-per cent reimbursement of consultancy fees for hiring experts on alternative technologies. In many countries, subsidies are directed specifically at small-scale enterprises, which often lack the financial and technical resources to undertake ODS phaseout without some outside support. The Multilateral Fund itself provides financial subsidies to investment in non-ODS-using technologies. The risk of reliance on investment subsidies is that it can encourage overinvestment or excessive risk-taking, though the benefits of encouraging a rapid switchover are normally assumed to justify the risk.

C. Incentives for Recovery, Recycling and Banking of ODS

As the global supply of ODS tightens, governments in Article 5(1) countries will need to consider measures to promote recovery and recycling of existing ODS supplies. While a continued steep rise in world prices for virgin ODS would strengthen incentives for recycling, a government may choose to reinforce those incentives with a levy on virgin ODS supplies.

This has been done in Australia, for example, where a tax of A\$1.00 per kg is levied on virgin ODS, with revenues used to defray the costs of its national recovery and recycling scheme.

A related approach designed to encourage recycling is a deposit-refund scheme. The concept is essentially the same as in the relatively familiar deposit-refund schemes used for beverage containers and other packaging materials. The US Environmental Protection Agency studied such a scheme in connection with a planned national CFC recycling program proposed in 1990 (see US Government 1990). Under such a system, a deposit fee would be added to the purchase price of the controlled substance at the appropriate point of sale. These fees would be refunded to persons or firms that returned used ODS to designated collection points for recycling. Alternatively, a recycling firm could arrange for the collection of ODS from user industries for central recycling. A deposit-refund scheme for ODS can be costly to administer, however. Moreover, centralised recycling is rendered more complicated where users are employing a variety of blended products and where the nature of impurities mixed with the ODS varies from user to user.

Recovery and recycling of ODS are likely to play a vital role in ensuring continued ODS supplies for maintenance of installed equipment in Article 5(1) countries once ODS production ceases in non-Article 5(1) countries. Banking of ODS stocks (whether virgin or recycled), which has already begun in the case of halons, could be expected to expand to CFCs in the future. ODS banking (discussed at greater length in Chapter 7) is analogous in some respects to a tradeable permit system, with the major difference that banking involves intertemporal trades - i.e., saving a portion of current ODS stocks for future consumption. As recovery and recycling become more widespread, then the ODS inventories available to supply future demand should include not only stockpiles of virgin ODS carried over from the final years of production in non-Article 5(1) countries but also the quantities installed in refrigeration and other equipment. A loan market for "banked" CFCs appears to be emerging, though it is still in its infancy (see Chapter 7). Governments may be able to facilitate the development of such a market, for example, through accreditation schemes for recyclers and provision of common testing and quality assurance facilities for recycled and banked ODS.

D. Permit Trades and Auctions

As noted above, quantitative restrictions on production and consumption of ODS are an integral part of most if not all countries' ODS phaseout strategies, and pro rating based on historic production/imports is the most common means of allocating the available supply. The main drawback of a straight pro rated allocation is its lack of flexibility. It does not allow for changing composition of ODS demand as different firms phase out at different rates. Thus, several countries have modified their allocation systems to enhance flexibility and cost effectiveness. There are a number of ways by which this can be done. One is simply to allow trading of the permits among registered firms, with the initial allocation still pro rated. Another is to auction off the available supply of production or import allowances to the highest bidder(s). A variation of this approach is a sealed bid tender. The main difference between a permit trading scheme and an auction is that in the former the enterprises selling their permits derive the financial rewards from ODS scarcity while in the latter the government captures the rents accruing to ownership of claims on the scarce ODS supply.

Singapore has pioneered the use of the permit, or quota, auction as a means of allocating its national ODS supply (see O'Connor 1991). Each quarter, ODS import permits are allocated among importers and users, half on the basis of historic demand (known as 'grandfathering,' this is intended to avoid sudden disruption of supplies to existing importers/users) and half through a tender. Each registered importer or user may submit a sealed bid specifying the quantity of ODS the bidder would like to purchase and its offer price. Bids are then ranked by price and the lowest winning offer price (i.e., the one which clears the market) becomes the permit price for all ODS import permits, including the pro rated half. While successful bidders must accept their auctioned allocation, firms have the right to forfeit their pro rated allocation. During the first few tenders after the system was introduced, there was a steep increase in permit prices (helped along by stockpiling). Consequently, user firms faced a strong incentive to adopt conservation measures and substitute technologies, which has contributed to a sharp reduction in ODS demand. By 1992, CFC and halon consumption had fallen to 37 per cent of its 1986 level. Moreover, the auction process has enabled the government to capture a sizeable portion of the quota rents, which it has used to subsidize recycling services and the dissemination of information on alternative technologies. The government has subsequently accelerated reductions in the national ODS quota in order to maintain upward pressure on the tender price.

As elsewhere, in Singapore the market-based approach has been combined with various command-and-control measures. For instance, in 1991 the government banned the import and manufacture of non-pharmaceutical aerosols and polystyrene sheets; in 1992 it prohibited the use of Halon-1301 for new installations and the import of Halon-2402; in 1993 it prohibited the use of CFCs in new industrial air conditioners and refrigerators (Toh *et al.* 1994).

New Zealand has introduced a simple permit trading system. To import CFCs, methyl chloroform or carbon tetrachloride a firm must possess a permit issued by the Ministry of Commerce. The amount each applicant is permitted to import is based on 1986 levels. Permit holders are free to sell or otherwise transfer their permits as long as they do so within the same user sector. In this way, the government is able to set different phaseout targets for each sector, depending on its evaluation of technical and economic feasibility.

Mexico is planning to introduce a tradeable permit scheme as well. The allocation of permits is to be done annually and any company possessing a permit is free to sell it to any other company. When a trade occurs, the selling company must notify the government in writing and the records are checked to ensure that the trade is in line with the permit; if so, a notification is sent to buyer and seller approving the trade. Permit trades may be only for a single year, or they may be permanent. In the latter case, in all years from the trade until ultimate phaseout, the company purchasing the permits is entitled to the seller's baseline quota allocation, whose value could be expected to appreciate as the ODS supply constraint becomes more binding. As substitution proceeds, that value should decline and when the phaseout is complete the quota allocation (or permit) has zero value.

E. Summary

Economic instruments can be, and usually are, employed as adjuncts to command-and-control measures. They are generally designed to achieve one or another sort of improvement over a straight CAC approach: (i) to improve the economic efficiency of ODS phaseout; (ii)

to achieve certain equity objectives. Taxes on ozone-depleting chemicals and tradeable permit schemes both possess efficiency-enhancing properties. They differ in other respects, however. A tax can also be used on equity grounds, to redistribute the windfall profits arising from increasing ODS scarcity. The drawback of a simple tax is the uncertainty of what rate will achieve the desired reduction in ODS demand. The marketable permit approach eliminates the uncertainty, but whether it can achieve equity objectives depends on the allocation rule for the permits. If the government simply allocates all the permits on the basis of historic consumption, it leaves the importers and users to share the scarcity rents. Those companies which happen to have had large historic consumption benefit inordinately from such a system. By contrast, an auction-type allocation enables the government to capture a sizeable share of the rents; if, as in Singapore, this is combined with the grandfathering of a portion of the permits, equity concerns of smaller and less wealthy consumers can also be addressed. Alternatively, as in the United States, an excise tax could be superimposed on the tradeable permit scheme to tax away some of the windfall profits, though as noted earlier the tax could prove redundant on incentive and efficiency grounds.

IV. VOLUNTARY AGREEMENTS

A few countries have relied extensively on voluntary agreements between government and industry as a key element of their ODS phaseout strategies. Such voluntary agreements have a long history in the field of environmental protection. One of their principal advantages is that they can be put into place fairly quickly, avoiding legislative or bureaucratic delays. Thus, they can serve as a useful interim measure while more comprehensive ones are put in place. In addition, the fact of their being voluntary implies that governments must first build support for ODS phaseout through consultations with industry, which enhances the prospects for industry compliance with any future regulatory measures. The example set by the participants in the voluntary agreements may also have a positive demonstration effect on other firms in a particular sector. A further feature of voluntary agreements is their flexibility; in the limit, a separate agreement could be negotiated with each ODS supplier and user, which would permit the tailoring of phaseout measures to individual enterprise capabilities. On the other hand, a firm-by-firm approach can involve high transaction costs if there are many ODS suppliers and users. One way of reducing such costs is for government to negotiate an agreement with an industry association rather than with individual firms. The process of consultation leading up to an agreement should help government to assess how rapid a phaseout is technically and economically feasible in a particular sector, given current and soon-to-be-available technologies. By working with an industry association, the government can also shift most of the burden of monitoring compliance with the agreement from its shoulders to industry's.

In Germany, voluntary agreements have been an important complement to regulations in the ODS phaseout effort. For instance, the government concluded a voluntary agreement with the aerosol industry that resulted in a reduction in CFC aerosol use from 53,000 tonnes in 1976 to 21,000 tonnes in 1987 and 2,000 tonnes in 1990 (the targeted date for achieving that level had been 1991); since then, this use of CFCs has been completely phased out (OECD 1993a).

Other non-Article 5(1) countries that make use of voluntary agreements include the Netherlands, Belgium and Norway. In the case of the Netherlands, in 1988 an agreement similar to that in Germany was concluded with manufacturers of aerosols. The effect of this agreement was that, since 1991, all aerosols destined for the consumer market are now filled with propellants that do not harm the ozone layer. Similarly, the government negotiated agreements with rigid foam producers, represented by the Dutch Association of Rigid Polyurethane Manufacturers (NVPU), to phase out their CFC consumption by 1 January 1993. In Belgium, voluntary agreements were concluded with industry on reduction of CFC use in foams (March 1989), aerosols (November 1989), and refrigerants (March 1991). In Norway, which depends entirely on imports of ozone-depleting chemicals, a voluntary agreement with industry played a significant role in reducing CFC imports from 1,411 tonnes in 1986 to 990 tonnes in 1989, 478 tonnes in 1991, and 255 tonnes in 1993. A total ban on CFC use comes into effect in 1995 (OECD 1993b).

A few Article 5(1) countries have also adopted voluntary agreements as a central plank of their ODS reduction programs. Mexico and Thailand are especially noteworthy. In Mexico, between 1989 and 1991, the government worked closely with industry associations to inform relevant industries of the requirements of the Montreal Protocol and to encourage adoption of voluntary agreements. During that period, 12 voluntary agreements were signed with two CFC producers and seven ODS users, setting out timetables for reductions. Several of the users were industry associations, including the Mexican Polyurethane Institute, Mexican Aerosol Institute, National Chamber of Industries, Chamber of Perfume and Cosmetics Industries, and National Board of In-Bond (Maquiladora) Industries. Industry representatives have supported an accelerated phaseout in line with the developed country timetable in anticipation of tightening ODS supplies and in order to keep abreast of the latest technology developments and thereby safeguard the international competitiveness of Mexican industry.

In Thailand, a tripartite arrangement has been forged involving the Thai Ministry of Industry and the relevant government agencies and industry groups of Japan and the United States, whose multinational corporate subsidiaries in Thailand were found to account for a very high percentage of ODS use, especially in the solvent cleaning sector. At a tripartite meeting in March 1992, some 33 Japanese companies and 11 US companies committed themselves to an accelerated ODS phaseout within their Thai operations. The arrangement is also meant to facilitate technology transfer from US and Japanese multinationals to Thai firms which act as suppliers, subcontractors, or joint venture partners. In a follow-up conference in early 1994, it was announced that Japanese companies would reduce CFC-113 and methyl chloroform use in their solvent cleaning operations by 43 per cent by 1995 and 90 per cent by 1997, while CFC-11 and CFC-12 use in the refrigeration sector was scheduled for a 95-per cent reduction by 1996. Some 7 Japanese domestic refrigerator manufacturers have plans to mass produce models which use HFC-134a refrigerant by early that year (Vicharangsarn 1994).

Malaysia is utilising a cross between a voluntary approach and a regulatory one in setting industry phaseout targets. At the individual firm level, the government has reached agreement with each locally-based affiliate of a multinational corporation on an ODS phaseout date. At the sectoral level, as noted above, the government has required each user industry (organised into six working groups under the National Steering Committee for the Montreal

Protocol) to draft its own timetable for ODS phaseout, indicating major problems, the measures proposed to deal with them, and the estimated costs of the phaseout.

Finally, New Zealand has adopted a policy which involves the drafting by industry groups (at government's behest) of codes of practice for ODS control. The first such code was called for by the Minister of the Environment from the automobile air-conditioning industry; a second code covers the plastic foam industry, a third the refrigeration/air conditioning industry, and a fourth the fire protection industry (Kraemer and Köhne 1992).

The level of public awareness of the stratospheric ozone problem can affect the willingness of ODS suppliers and users to undertake voluntary control measures. Where the public is sensitive to the environmental implications of consumption choices, industry may perceive opportunities to enhance consumer good will by introducing and advertising non-ODS-using products and processes and by announcing their active co-operation with government in achieving a rapid ODS phaseout.

In summary, voluntary agreements have a few advantages which can make them attractive as elements of an ODS phaseout strategy. They can be negotiated and implemented with a minimum of delay, since they do not require new legislation or regulations. They are highly flexible instruments: though it is possible to negotiate individual agreements, it is probably more economical to deal with industry associations since, in any case, firms within a given industry are likely to encounter similar technical and economic problems. A common agreement with an industry association can reduce government's monitoring costs and facilitate information dissemination concerning non-ODS-using technologies. Experience suggests that firms are more likely to enter into voluntary agreements when the alternative is likely to be a government-mandated reduction program, or when they perceive a commercial benefit in the form of increased customer good will. Normally, voluntary agreements will constitute just one small component of a larger strategy - their principal function being to accelerate the phaseout among major ODS users and in the process to demonstrate that an accelerated phaseout is not only feasible but possibly even profitable.

V. BROAD DIRECTIONS FOR ODS POLICY FORMULATION IN ARTICLE 5(1) COUNTRIES

As the country experience described thus far suggests, the policy regime for ODS phaseout is likely to consist of a "cocktail" involving a mix of regulatory, economic and voluntary measures. The particular mix will depend on characteristics of the individual country and its level and pattern of ODS production and use. Some of the relevant factors which will affect policy design are identified below; then broad guidelines are proposed which are intended to assist policy makers in Article 5(1) countries, particularly those which are still at an early stage in ODS policy formulation.

A. Country Characteristics Bearing on Policy Choices

A number of Article 5(1) countries have already made substantial progress in designing and implementing ODS phaseout strategies and policies. Others stand to learn valuable lessons from them as well perhaps as from the experiences of non-Article 5(1) countries. There is a considerable heterogeneity in the characteristics of the ODS sectors of

different Article 5(1) countries, not to mention in the broader legal, institutional and policy framework. Relevant considerations in defining an appropriate policy regime include the following:

- the extent of development of market institutions in general and of markets for ODS and ODS-using products in particular;
- the capacity of government to monitor compliance and to enforce laws and regulations;
- the fiscal culture, including the capacity of government to collect taxes and the public acceptance of new tax measures;
- the level of education of the population and the potential for raising public awareness of the stratospheric ozone problem.

1. The Degree of Development of Market Institutions

The degree of familiarity with a market system of resource allocation varies widely among Article 5(1) countries, though economic reforms in certain of the centrally planned economies have greatly expanded the degree of reliance on markets. It may take some time, however, for governments to become adept at employing market-based instruments; moreover, other elements of the policy regime may render such instruments ineffectual. For instance, excise taxes levied on ODS production or imports would have little incentive effect where ODS producers or importers (e.g., state enterprises) can avail of government subsidies to cover their higher costs.

Apart from the general level of market development, it is also important to consider the structure and functioning of ODS markets. A common structure in many countries is one in which supply of ODS is highly concentrated in a few firms - whether producers or importers - while use is much more widely dispersed. Where only a few firms are involved, direct regulation is relatively simple, while a large number of dispersed firms creates monitoring and enforcement problems. At the same time, a concentrated upstream industry structure makes it difficult to establish competitive market conditions, while the larger number of downstream ODS users fosters greater competition. For these reasons, it may be appropriate to utilise a combination of direct regulation on upstream suppliers (e.g., import controls where a country has no domestic production) and market allocation to domestic downstream users (see Munasinghe and King 1992). As the quantitative restrictions will tend to raise prices, downstream users will face incentives to economize on ODS use. If an oligopolistic supplier sector is not to reap unusual profits from this situation, government may need to impose an excise (or windfall profits) tax on that sector. While a quota auction might attain the same objective, there is a risk of collusive bidding where numbers of participants are very small.

2. Government Monitoring and Enforcement Capacity

Weak government capacity to enforce laws and regulations is a common problem in many Article 5(1) countries. This is apt to be especially true in an area like ODS phaseout where the required expertise is likely to be in scarce supply. Moreover, within many Article 5(1) countries, there are serious conflicts of interest between different ministries: those charged with enforcing environmental standards and policies may not only receive little budgetary support but may actually encounter strong political resistance from those charged with promoting economic development. Where there is as yet a limited public constituency for environmental protection, the environmental administrator is likely to labor at a competitive disadvantage. However, such a conflict is likely to be somewhat muted in the case of ODS phaseout, since external financial and technical resources should be available from the Multilateral Fund.

A common complication of monitoring and enforcement in many developing countries is the large number of small enterprises operating outside the formal economy or, in other words, without the permission or often even the knowledge of the government. To the extent that this is the case in ODS using sectors, government could be expected to have difficulty monitoring and control their activities. If the supply of ODS can be effectively controlled at the border, then both formal and informal sector ODS users will be affected by the tightening supply. Still, if for whatever reasons informal sector firms prefer to remain anonymous, they would not be in the same position as formal sector ones to avail of the financial resources of the Multilateral Fund to help them adjust to the ODS supply constraint. Moreover, it is a fact that in many Article 5(1) countries, borders are porous and supplies of ODS may be difficult to exclude when the incentive to smuggling is high.

3. Fiscal Culture

Many Article 5(1) countries rely on indirect taxes for a sizeable portion of government revenue generation. Trade taxes have historically made up a large portion of such revenues but with trade liberalisation the emphasis has tended to shift to domestic taxes, in particular value-added taxes. Excise taxes are also a common feature of many countries' tax structure. Thus, the capacity to administer an ODS excise tax may well already exist. However, tax evasion remains a pervasive phenomenon in many countries, so the mere imposition of a tax does not assure its collection. Where all ODS are imported, then a border tax may be the most effective means of diminishing scope for evasion. Still, misdeclaration of imports is commonplace, as is bribery of customs officers. A particular dilemma arises as trade in recycled ODS expands: a government which taxes ODS imports might choose to exempt recycled ODS so as not to discourage recycling, but this may encourage the mislabelling of virgin ODS as recycled ODS. A global system of reporting and information sharing which would enable Parties to track movements of recycled ODS could help guard against such abuse.

A government considering the introduction of an ODS tax can expect to encounter resistance from ODS industry participants, who may well argue that the tax would undermine their competitiveness. Even without such resistance, it may still be time-consuming to introduce a new tax measure if it must be passed by the legislature. Thus, governments may find reliance on regulatory measures more politically appealing. The effect of strict

quantitative controls would still be to raise prices to users, but government may not be perceived as directly responsible for the price increases. Nevertheless, against this presumed political benefit government needs to weigh the possible political cost of allowing a few private firms to capture windfall profits from the policy-induced ODS scarcity. Moreover, there is the foregone revenue which might have been used towards financing the ODS phaseout effort, including perhaps rebates to enterprises undertaking investments in alternative technologies. Thus, if equity concerns need to be addressed but an excise tax proves politically infeasible, a permit auction may be the preferred solution.

The most politically attractive policy approach is likely to be one based on voluntary undertakings by ODS suppliers and users to meet certain phaseout targets. If compliance is indeed voluntary, then such an approach will almost certainly have to involve accelerated phaseout, since the government will need to leave some time for implementing CAC measures if industry exhibits bad faith. Thus, a system of voluntary agreements will in general need to be backed up by the threat of eventual sanctions for non-compliance. Alternatively, government must ensure that industry is sufficiently convinced it is in its self-interest to follow its agreed phaseout schedule that little policing is required.

4. Industry and Public Awareness

Whether industry sees advantages to voluntary phaseout of ODS depends to a significant degree on its own level of awareness of the issue and that of the consuming public. It has been pointed out elsewhere that in some countries (notably Mexico) industry has indeed been persuaded of the advantages of an accelerated ODS phaseout. Loss of competitive position in both domestic and export markets to non-ODS-using technologies is among the most persuasive commercial arguments. That in turn is a function of two interrelated factors - the shift in consumer preferences away from ODS-using products and the declining costs of non-ODS-using alternatives as their production expands to meet the growing demand. If an ODS user industry is primarily export oriented, then the attitudes of consumers in major foreign markets are critical. In the case of domestic market oriented industries, public awareness raising and educational campaigns can be important forces shaping demand for non-ODS-using products. While government can provide valuable support to such campaigns, often non-governmental organisations (NGOs) will prove equally or more effective in conducting them.

B. Guidelines for the Design of ODS Phaseout Policy

Based on the preceding discussion, it is possible to identify a number of general pointers to which governments may choose to refer when designing their ODS phaseout strategy and policy regime. Any set of policies must strike a balance among several at times conflicting objectives: effectiveness in achieving timely phaseout, economic efficiency, equity, political feasibility and ease of implementation.

1. *The simpler the policy regime, the easier it is to implement.* As a general rule, governments should aim for as simple a policy regime as is consistent with the achieving their phaseout timetable and meeting other priority objectives. Neither complex regulations nor sophisticated economic incentive schemes are very useful if the institutional capacity to administer them effectively is lacking. Since institutional capacity is apt to be weakest early

in the phaseout effort, simplicity of design is especially important at the outset. If subsequently there is a perceived need for more sophisticated measures, then these can be introduced as the institutional capacity to implement them develops.

2. *A mixed policy regime is normally to be preferred over a pure one.* A regime combining regulations, economic incentives and/or voluntary agreements is almost inevitably somewhat more complicated than one based on a single type of instrument. Nevertheless, within limits the advantages from added complexity - namely, allowing attainment of multiple objectives - should outweigh any disadvantages. Command-and-control measures can reduce substantially any uncertainty that phaseout targets will be met; economic instruments can reduce compliance costs of firms with a given phaseout schedule; voluntary agreements can reduce the administrative burden on government and increase the political acceptability of the phaseout program.

3. *ODS supply controls should be targetted where they can be enforced most effectively.* Normally, for the majority of Article 5(1) countries which depend on imports for their ODS supply, border measures are the most appropriate. Moreover, suppliers and importers are generally far fewer in number - and hence easier to monitor - than users. This does not imply that the user sectors can be ignored: they will normally require technical and financial assistance in adjusting their operations as ODS supplies become scarcer and more expensive.

4. *Sector-specific measures may be useful to encourage accelerated phaseout where technologies permit.* Where cost-effective alternatives have already been developed, it may be advisable to force the adoption of those technologies by imposing sectoral bans on ODS use. This has been done extensively in the aerosol sector and with rigid foams. While one would expect the forces of competition alone to force ODS users in such sectors to switch to more cost-effective alternatives, the introduction of a sectoral ban can still act as an effective catalyst. The use of a sectoral ban in such circumstances carries few costs, since user firms should actually enjoy improved profitability after the switch over.

5. *Whatever the mix of policy instruments, close consultation with affected industries should enhance cooperation, hence lower monitoring and enforcement (M&E) costs.* An ODS phaseout program not enjoying the support (even if at times reluctant) of affected industries is likely to be costly if not impossible to implement effectively. Governments in many Article 5(1) countries have only very limited in-house monitoring and enforcement capabilities. To economize on M&E effort, governments therefore need to enlist other social actors, including the affected industries themselves. Those industries are more likely to cooperate when they have been consulted in advance and been allowed to make an input into the policy formulation process. Environmental NGOs can also be valuable participants in the design and implementation of the ODS phaseout program.

6. *Control measures should not unduly penalize small ODS users; special measures may be needed to assist their adoption of alternative technologies.* For a number of reasons, small-scale enterprises, especially those operating in the informal sector, may operate at a competitive disadvantage in adapting to policy initiatives for ODS phaseout. They may have limited access to information on alternative technologies, limited financial resources to acquire them, and limited technical competence to master them. For all these reasons, government

may need to devise special outreach programs to reach such firms and offer special financial incentives for hiring technical expertise and investing in new technologies.

7. *Voluntary agreements should be encouraged wherever possible as they involve little cost to government and have a number of potential benefits; they are especially useful as an early policy initiative.* Voluntary agreements may well appeal to some of the bigger ODS suppliers and users, which may also be among the larger companies operating in the country. Where those companies have a brand image to uphold and are concerned about consumer good will, being seen as an environmentally responsible corporate citizen has its commercial advantages as well. Thus, if successful, the voluntary approach can yield significant early reductions in ODS consumption and thereby lend credibility to the government's phaseout efforts.

8. *As ODS supplies become tighter in coming years, governments need to give greater emphasis to policies to promote recovery, recycling, and banking.* In the transition to the next phase of implementation of the Montreal Protocol, when ODS production has effectively ceased in non-Article 5(1) countries, effective management of existing stocks of the chemicals will be critical to ensuring that installed ODS-using equipment can be maintained for the remainder of its useful life. Since the stock of such equipment may well continue to grow in many Article 5(1) countries for a number of years still, the question of ensuring adequate ODS supplies for servicing takes on added urgency. While a high price for virgin ODS is itself an incentive for recovery and recycling, governments may need to consider other measures to encourage greater recovery and recycling. One approach already being applied in a number of countries is to subsidize investment in recycling equipment, whether by individual firms or by a common recycling facility servicing many small users. Resources from the Multilateral Fund have been made available for a number of recycling projects in Article 5(1) countries.

Measures to encourage ODS banking operations may also be called for; some policy initiatives in this area are discussed in Chapter 7.

VI. CHAPTER SUMMARY

Information dissemination and public and industry awareness raising are important preconditions of an effective phaseout strategy. Voluntary agreements for ODS reduction by industry can generate publicity and momentum for the broader phaseout effort. Governments may want to promote such agreements, perhaps involving industry associations as a way to encourage collective self-policing by industry; non-governmental organisations (NGOs) may also be a party to such agreements, providing an independent monitoring capacity. Such agreements can be put in place quickly since they do not require legislation or regulations; they can thus buy time while regulatory and other instruments are developed and implemented. Most countries will opt for some sort of quantitative restrictions (quotas), normally managed through an import and (in some instances) production permit/license system. Permit trading can be a relatively simple means of generating efficiency gains, though the extent of gains depends on how widely phaseout costs vary across sectors and individual users. By means of a permit auction or the levying of an excise tax on ODS supplies, governments can capture some of the windfall profits (or scarcity rents) which otherwise would have been enjoyed by the ODS suppliers; those revenues could be put

towards building up an ODS recovery/recycling capacity, providing financial support to small and medium enterprises for ODS phaseout, etc. Clearly, recycled ODS need to be exempted from any tax if it is to have the desired incentive effect and careful consideration needs to be given to the risk of tax avoidance behavior. In the end, a mixed strategy combining legal and regulatory measures, economic incentives, public awareness raising and voluntary agreements with industry is apt to be best suited to reconciling the multiple objectives of phaseout timeliness, cost effectiveness, equity and political feasibility.

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CHAPTER 5

INFORMATION, INNOVATION AND THE MONTREAL PROTOCOL

I. INTRODUCTION

A common problem of individuals and organizations is the effective communication of ideas, knowledge and information. Even more problematic is the communication of new ideas since change itself is challenging. Altering practices that deplete the ozone layer requires changing behavior patterns deeply embedded in the routine meanings and behaviors of cultures, nations, organizations, industries, and individual consumers across the globe.

The *types* of information pertinent to global change of ODS practices span the full range of human communication forms, from the theoretical and scientific, through the technical and procedural, to the interpersonal and emotional. The *channels* that carry ODS information range from formal mass media to interpersonal conversations. The message *forms* include formal ones, like scientific journals and government regulations, less formal ones like industry manuals and association newsletters, to very informal ones like conversations over dinner or during a workshop. Communication channels and messages are organized into socially-based communication *systems*; the way these social meaning systems operate affects their ability to get new ideas adopted. One can even think of a social system as going through a gradual learning process regarding an innovation, as the aggregated experiences of the individuals with the new idea builds up and is shared among them through interpersonal *networks* (Rogers 1983:293).

The past five years, which may be considered Phase 1 of the Montreal Protocol implementation process, have been ones of experimentation, evolution and progress in the creation of a functioning communication system for ODS phaseout. While the system has not been perfected, its creation is a major accomplishment of Phase 1. We now have the opportunity to reflect on the lessons learned from the experiences of this system of information exchange so that the future may hold an even smoother and swifter transition.

During Phase 1, information needs were identified, problems were articulated, and communication structures were created. The Protocol's implementing agencies built their internal capacities to support phaseout activities and began to carve out their roles vis-à-vis each other and the Article 5(1) countries. For example, the World Bank, reports "substantial investment...in *building streamlined procedures and in establishing sustainable ...[ODS] phaseout mechanisms* in major ODS consuming countries over the period of 1991-1993" (World Bank, 1994: Executive Summary, p. 1, italics supplied).

Four major information sharing networks have emerged during Phase 1; each is organized around a different focus. These four networks are linked via bridging individuals and their institutional positions. They are also connected via a broader, boundary spanning global ozone community.

II. BACKGROUND

In its 1991 report, UNEP's Technology and Economic Assessment Panel (TEAP) emphasized that the barriers to rapid ODS phaseout were largely informational and administrative rather than technical and economic. Two years later this sentiment was repeated at the International CFC and Halon Alternative Conference: "Sharing of information on technology, products, services and policies is the key to cost-effective and expeditious phaseout of ODS" (UNEP IE/PAC 1993). The complexity and changing nature of the scientific and technical issues involved in protecting the earth's ozone layer require a process by which new information can be produced, shared, and, where appropriate behavior modified or changed.

While the Protocol technically obligates nation-states and provides for a global governmental information infrastructure (see Article 9), it also encourages the creation of innovative partnerships that share technology, information, and organizational resources. That is, it is the Montreal Protocol itself that encourages the emergence of networks of information exchange -- it supports creative partnerships and links the fate of developed and developing countries. (See Canan & Reichman 1993.)

III. FOUR INFORMATION EXCHANGE NETWORKS IN ONE SYSTEM COORDINATED BY A COMMUNITY

During Phase 1 of the implementation, four ODS information exchange networks emerged under conditions of urgency rather than methodical planning. Overlapping in purpose and in membership, these networks operate as a communication system that facilitates the ODS phaseout process. Redundancies and inefficiencies have existed, as should be expected in the early experimental phase of implementation. Now we may anticipate that the near future will be both calmer and more turbulent. It will be calmer in that networks have been built, procedures have been established and implementing roles have been defined, and more systematic procedures have been created. The future will be more turbulent in that more Article 5(1) nations are poised to act and thus will place heavier demands on the networks and their resources to assist in the phaseout. Approaching deadlines will also add to a heightened sense of urgency to identify and surmount existing barriers to complete phaseout.

The four ODS networks range along a continuum of orientation, with continuum points depending on focus: Policy, Program, Project, and Product. (See Table 5.1.) And despite natural overlaps along the continuum, there are significantly different foci that give each network a particular kind of social organization. Furthermore, the success of this system of four networks is primarily a function of the effective *bridging activities across all networks* accomplished by a public/private Protocol community that spans scientific, industrial, national, and ministerial institutions around the world. (See Haas 1990; Lee 1994.)

A. The Global Ozone Community: A "Clan"

The "*Global Ozone Community*" is a community in the sense of sharing common ties, being bonded by a set of common meanings, active in social interaction (Bernard 1973) and consciously aware of itself as a community, or a "clan."¹ This clan is not a common or typical network, but an "*epistemic community*"² of actors who participate in a diverse set of capacities, and who share the ability to test the often assumed desirability of linking discipline with organizational virtue (Clegg 1989). Through their interactions, the members of the "Global Ozone Community" give meaning to the "rules of the game," define what is possible, define what is success and failure, and determine where to go from here. Essentially this community creates the meaning of regulation in this global environmental regime.³

¹Over the last five years the author has frequently overheard people involved in ODS phaseout policy, program and project activities speak of themselves as members of an ozone "clan," "club," "global team," "family" with "generations," and "club of confidence."

²Holzner and Marx (1979: 108) define *epistemic communities* as "those knowledge-oriented work communities in which cultural standards and social arrangements interpenetrate around a primary commitment to epistemic criteria in knowledge production and application."

³Some examples of agreement worked out within the Global Ozone Community are a preference for substitution chemicals and production processes rather than drastic alterations of lifestyle or consumption patterns; a working definition of big, medium and small ODS consumption economies for program work; the naming of refrigeration as the "big problem" as of 1994; and an understanding that cultural factors combine with scientific facts in defining risk regarding technology.

Table 5.1
OVERLAPPING NETWORKS
IN THE GLOBAL ODS INFORMATION EXCHANGE SYSTEM

NETWORK FOCUS	NETWORK ACTORS	EXAMPLE OF NETWORK ACTORS
	<i>"Global Ozone Community"</i>	<i>Annual International CFC & Halon Alternatives Conference; UNEP Technical Options Panels</i>
Policy	Executive Committee of the Montreal Protocol	7 Non-Article 5(1) Countries 7 Article 5(1) Countries
	Secretariat of the Montreal Protocol	UNEP, Nairobi, KENYA
	Fund Secretariat of the Montreal Protocol	UNEP, Montreal, CANADA
	Nation-state Parties	Brazil, Germany, Sweden, Malaysia, Egypt
Program	Implementing Agencies of the Montreal Protocol	UNEP, World Bank UNDP, UNIDO
	Non-Governmental Organizations	Greenpeace, Friends of the Earth World Wildlife Federation
	National Government Agencies	Environmental Protection Agency (USA), FINEP (Brazil), MITI (Japan), Turkish Ministry of the Environment, Environment Canada
	Country Programs and National Ozone Offices	Egypt's National ODS Phase Out Program China's National Ozone Office
Project	Industry Associations	Industry Cooperative for Ozone Layer Protection (ICOLP), Mobile Air Conditioning Society (MACS), Association for Fluorocarbon Consumers and Manufacturers (AFCAM)
	Regional ODS Networks	South-East Asia ODS Network
	Multinational Corporations	AT&T, Mitsubishi Electric, ICI
	Large Corporations	Ontario Hydro, US Navy, Northern Telecom
Product	Individual Companies Consumers	Thai Airlines, XYZ Refrigerator Shop My family and yours

The members of the Global Ozone Community are formally employed in powerful associations, multinational corporations, and national governments. It is common for these actors to negotiate "deals" that cross typical occupational, professional and institutional boundaries. (See Canan and Reichman 1993.) Narrow allegiances have been expanded by the shared strong commitment to eliminate ODS, by intense personal interaction, and by the trust that has been built upon repeated, shared ODS-problem experiences. Creative mold breakers are recruited to this community, and "vets" speak of "back in the old days" and now having to socialize "the new generation." Such experiences as roll-up-your-sleeves committee work, a series of back-to-back international workshops, or a successful, though episodic, team effort on a specific phaseout project work to bind members closely together. (See Granovetter 1973 on the "strength of weak ties.") The effective action, camaraderie, and mutual understandings forged by this community are largely responsible for the implementation progress to date.

There are a number of fairly loosely coordinated mini-networks and key actors who are "network spanners" in the Global Ozone Community. Thus, the Global Ozone Community binds other primary, overlapping ODS information exchange networks through expertise, resolve and, especially, self-awareness as a community. A good representation of the community's membership and network overlaps may be found by looking at the Program of the 1994 International CFC and Halon Alternatives Conference held in Washington, DC October 24-26. The meeting, sponsored by the Alliance for Responsible Atmospheric Policy in cooperation with the US. Environmental Protection Agency, Environment Canada and the United Nations Environment Programme, was hailed as "the most important event in the world which brings people together to solve this environmental problem" (Conference Brochure 1994).

The Conference was officially endorsed by a cross section of industry associations and research institutes.⁴ Program chairs represented industry, government and research laboratories, and heads of industry consortia. Sessions covered advances in technology, commercial material compatibility, not-in-kind alternatives, risk taking and safety, recycling, reclaiming, redistribution and disposition of chemicals, regulatory frameworks, current issues like halon banking and "essential uses," technology transfer, the nature of knowledge sharing networks, and successful stories of phaseout cooperation. Informal gatherings at the

⁴The Conference "endorsing associations" are Air Conditioning Contractors of America, Aerospace Industry Association, Association of Home Appliance Manufacturers, American Automobile Manufacturers Association, American Frozen Foods Institute, Association of Electronics Manufacturers, Association of Professional Energy Managers, Building Official and Code Administrators, Center for Emissions Control, Commercial Refrigerator Manufacturers Association, Food Marketing Institute, General Aviation Manufacturers Association, halon Alternatives Research Corporation, Halong Recycling Corporation, Heating, Refrigerating, and Air Conditioning Institute of Canada, Institute of International Container Lessors, International Association of Refrigerated Warehouses, Mobile Air Conditioning Society, Mechanical Service Contractors Association, Ontario Refrigeration and Air Conditioning Contractors Association, Polyisocyanurate Insulation Manufacturers Association, Refrigeration Service Engineers Society, Southern Building Code Congress International and the Society of the Plastics Industry.

conference were occasions of swapping stories and memories of the "old days of ODS work," trading stories of experiments, successes, and failures, and sharing photos of family and snapshots taken of "ozone buddies" at previous conferences, workshops, or ODS project sites.

B. The Ozone Policy Network

At the heart of the *Ozone Policy Network* are the Parties to the Protocol, the Protocol's Executive Committee, its Secretariat in Nairobi and the Secretariat of Multilateral Fund in Montreal. The Policy Network aim has been to create the global organizational infrastructure to make visible, workable links across public sector actors and to support the Protocol's encouragement of international public-private partnerships for ODS phaseout. The Policy Network is naturally driven by political concerns and by norms of universality and transparency in its support for technology and information transfer and its expenditure of financial resources. It has successfully established a common global commitment to specific transitional substitute chemicals and agreed upon many workable alterations of implicated productions processes. It has also ironed out responsibility, procedures, and guidelines to be followed by decision makers in the Ozone Program Network. While not overly contentious, the past few years' experience portends a period of relative routine evaluation and streamlining.

Primary members of the Policy Network are the Implementing Agencies (UNEP, World Bank, UNDP and UNIDO), individual national governments and their ministries/agencies (for example, the US EPA) and global non-governmental organizations (NGOs)⁵ Independent consultants may serve multiple implementing agencies and participate in the groups that comprise the Global Ozone Community (GOC), as do, for example, members of the World Bank's Ozone Operations Resource Group (OORG) and UNEP's Technical and Economic Options Committee (TEAC) which act to connect the Policy Network to the larger GOC.

C. The Ozone Program Network

The Implementing Agencies act as a tie between policy and program foci in the overall implementation system. The *Ozone Program Network* is primarily concerned at the operational level. In May 1991 the Executive Committee invited the original three implementing agencies (UNIDO was not so designated until 1993) to assume the following roles (UNEP 1991).

"The Agencies will accept the invitation of the Parties to co-operate and assist them within the respective areas of expertise of the Agencies as follows:

"(a) The United Nations Environment Programme shall be invited by the Executive Committee to co-operate and assist in the political promotion of the objectives of the Protocol, as well as in research, data gathering and the clearing-house functions, which are identified as follows:

⁵Examples of NGOs in the Ozone Policy Network are Greenpeace, the World Wildlife Federation, and Friends of the Earth.

"(i) assist [Article 5(1)] Parties...through country specific studies and other technical co-operation, to identify their needs for co-operation,

"(ii) facilitate technical co-operation to meet these identified needs,

"(iii) distribute...information and relevant materials, and hold workshops, training sessions, and other related activities, for the benefit of Parties that are developing countries, and

"(iv) facilitate and monitor other multilateral, regional and bilateral co-operation available to parties that are developing countries;

"(b) The United Nations Development Programme shall be invited by the Executive Committee to co-operate and assist in feasibility and pre-investment studies and other technical assistance measures; and

"(c) The World Bank shall be invited by the Executive Committee to co-operate and assist in administering and managing the programme to finance the agreed incremental costs."

Since 1991 the agencies' responsibilities have blurred as each agency, and some individual countries under bilateral arrangements,⁶ have conducted training workshops, and worked on "country programs" for Article 5(1) countries, the central focus of this network during Phase 1 of the implementation.⁷ An example of the expansion of agency purview may be found in UNDP, with its report of currently "assisting 30 governments in planning, preparation and implementation of country programmes, projects and sectoral activities...through technical assistance/training, feasibility and pre-investment studies, national capacity building, demonstration projects and technology transfer investment projects" (UNDP Montreal Protocol Unit 1994).

The Country Program has been defined as presenting "a commitment by the government to take appropriate actions to ensure compliance with the control measures of the Protocol" (UNEP 1991b). The Ozone Policy Network through the Executive Committee has provided the Program Network with policies for preparing country programs. Each country program should have the components listed in Table 5.2. The guidelines promote research, discovery, and action planning⁸ They support the identification of individual projects and the assignment of priority rankings according to the national government's commitment to the phaseout. In so doing, the Policy Network asks the Program Network to give direction to the individual phaseout projects conducted by the Ozone Project Network.

⁶See for example US EPA, 1994.

⁷Writing a "Country Program" to the Fund's Executive Committee has become a first step toward obtaining assistance from the Fund. (See Paragraph 10(g) of Appendix II of Annex IV to the Report of the Second Meeting of the Parties.)

⁸The guidelines for format and content of a Country Program are contained in UNEP/OzL.Pro/ExCom/5/16, Annex III, pp. 24-40.

Members of the Ozone Program Network range from representatives of the Implementing Agencies to government agencies (e.g., US EPA) and industry associations (e.g., ICOLP) within and across member countries that together form an identifiable horizontal layer of assistance within the Program Network. The assistance layer is connected to the assisted layer of Article 5(1) countries through links made by technical and administrative consultants, who themselves may be government employees, employees of industries making changes in their production or consumption patterns, or who may be self-employed consultants.

Concerned as well about effective communication with national governments, and about supporting information flows between individual nations and the assistance layer, the Program Network has supported the creation of formal *channels of information flow*. By 1994 the national governments in 84 Article 5(1) countries had designated official responsibility for ozone layer activity at the national level. Some countries have created National Ozone Offices; other countries have identified existing officials/agencies to act as "Focal Points" for information transfer. National Ozone Units were conceived as primary conduits for information exchange, with routine distribution of UNEP IE/PAC general and technical information products. In most cases nations have identified a local organization (in the Country Program) that will act as the national link to the international effort. These national offices are supported with institutional strengthening funds. Regional offices within the pre-existing United Nations structure are also used for disseminating information where national ozone offices have not been established. (See Appendix 5.1 for a list of National Ozone Offices/Focal Points.) UNEP has also begun creating *regional networks* for sharing ODS program goals, obstacles, and lessons under this same rationale.

One of the first activities of the Program Network was creating a formal *information clearinghouse* designed to be a "pointer system." UNEP established the OzonAction Information Clearinghouse (OAIC) August 1992 to transfer information on policy and technical options for the phaseout of controlled ODS. Available through regular telephone line, as well as through national packet switching networks, it contains descriptions of alternative technologies; a database of ODS-reduction products and services; national and corporate program summaries; a calendar of ODS-reduction events; an international directory of ODS-reduction experts; abstracts of ODS-reduction documents; a message centre; and news bulletins describing the latest worldwide developments in ODS-reduction.⁹

⁹OAIC responded to more than 500 queries in 1992; 626 queries in 1993, and 500 queries in the first six months of 1994. Article 5(1) countries have increasingly made use of the OAIC, facilitated in part by Multilateral Fund support for institutional strengthening.

Table 5.2**Information Contained in a Country Program: Executive Committee Guidelines**

Purpose	Government's commitment, basis of Action Plan; framework for assistance; consistency between specific projects and overall Country Program; basis for monitoring
Status	Description of the preparation of the Country Program, agency that prepared it, costs of preparation, government agency endorsing it
Assistance Received	Sources and nature of all assistance received in preparing the Country Program.
Current Consumption of ODS	Data or estimates of the current consumption of all controlled substances in tons, analyzed by substance, and analyzed by each substance by source, user sector, applications, and recovery activity. Source refers to production, imports and exports. Uses include refrigeration, air conditioning, foams, aerosols, cleaning, fire fighting, and process solvents. Applications include recharging, chemical or manufacturing processes and feedstock. Recovered and recycled ODS should be reported by type or application.
Forecast Consumption	Forecasts for period 2010-2015 of the use of each substance in tons and in tons x ODP, by product type or industrial user, under two scenarios
Industry Structure	Structure and ownership of the industries producing, importing and using ODSs
Institutional Framework	Government departments and agencies, non-governmental organizations, industry/trade associations and consumer groups relevant to implementing the commitment to phase out of consumption of ODSs
Policy Framework	Description of relevant policy framework within which the phase out of ODSs will be managed, addressing governmental policy orientation to regulation, laws and regulations available to empower actions; policies relevant to industrial development including ownership of companies in particular economic sectors, sectoral preferences for indigenous production/manufacturing versus imports; powers held by government to implement industrial development policies
Government and Industry Responses to the Protocol	Significant actions already taken by government or by the producer and user industries in response to the Protocol
Strategy Statement by Government	Statement of the strategic objectives and constraints on which the preferred Action Plan is based, the phase out schedule for each group of substances, with planned consumption by year, and year when zero consumption is achieved
Action Plan	All actions the government intends to initiate in order to implement the phaseout of ODS
Projects	A prioritized listing and description of each project expected to be undertaken within producer and user industries in response to the government's commitment to phase out consumption of ODS

OAIC requires collecting, verifying, organizing, formatting and retrieving information. These activities are constant staff demands as information must be kept up-to-date and it forms the basis of such *information products* as pamphlets, brochures, and newsletters, the Sectoral Data Collection, the OzonAction Library,¹⁰ Listings of ODS trade names, and the IRHBMIC (International Recycled Halon Bank Management Information Clearinghouse). One experiment, the creation of the solvents industry database (known as OZONET) that was donated to UNEP IE/PAC by ICOLP, has not been up-dated since 1992.

IE/PAC's newsletter *OzonAction* that has been produced quarterly since March 1992 and published in Arabic, Chinese, English, French and Spanish. In the last two years the newsletter has improved in content, quality, accuracy, and timeliness. Readers are complimentary on the whole, having suggested that greater technical rigor, longer issues and more frequent mailings would be ideal (Rowcliffe 1993). Two alternative technology catalogues -- one for the aerosol and sterilant sector and one for solvents -- were published in 1994 through the collaboration of UNEP IE/PAC and technical experts from around the world (*OzonAction*, July 1994). Currently an "Information Kit" to be used for general public awareness campaigns in individual countries is being created.

D. The Ozone Project Network

Projects that translate policy and programs into action are the focus of the *Ozone Project Network*. This network has a more clearly private sector flavor. Typically the network relies on industry associations and routine business structures (e.g., relationships as suppliers, vendors, subsidiaries e.g.) to carry suggestions for industrial transformation. ODS information can be spontaneously, even informally, exchanged as firms engage in their daily business activities, e.g., introduce new product lines, alter production processes in branch plants, train new workers on site. Information cooperation within the Project Network is exemplified by the refrigeration industry. It has established two clearinghouses and databases specializing in alternative refrigerants and related information. These are the Air-Conditioning and Refrigeration Technology Institute (ARTI) Refrigerant Database funded by the US Department of Energy and the American air conditioning and refrigeration industry and the International Institute of Refrigeration's (IIR) FRIGINTER and FRIGDOC. (For more information on these services, see UNEP 1994c.)

¹⁰Materials include OAIC Document Abstracts, OAIC Halon Sector Document Abstracts; OAIC Methyl Bromide Document Abstracts; World Wide List of producers of Controlled Substances and ODS Alternatives; Alternative Technologies Approved by the IMOF; Case Studies on Retrofitting; Success Stories in Phasing Out; and many UNEP IE/PAC publications.

Some industry associations are committed to Article 5(1) country phaseout activities and have become involved in phaseout projects as an association per se.¹¹ For example, ICOLP, the solvent industry's "Industry Cooperative for Ozone Layer Protection" was established in 1989 to coordinate the open, worldwide exchange of non-proprietary information on substitute technologies, substances and processes for CFCs in the electronics industry. Today its corporate members span Canadian, Japanese, American, and British industry and its affiliate members cover academic, governmental and industrial actors from around the world including Sweden, Korea, Japan, Taiwan, Turkey, Russia, Mexico, USA.¹²

By 1994 four of ICOLP's original members -- Boeing, Compaq Computer, Digital Equipment and General Electric -- had dropped out of the cooperative. Currently the 12 corporate members of ICOLP are AT&T, British Aerospace Defense, Ford Motor Company, Hitachi, Ltd.,¹³ Honeywell, Inc., IBM Corporation, Mitsubishi Electric Corporation,¹⁴ Motorola Corporation, Ontario Hydro, Northern Telecom, Ltd, Texas Instruments, and Toshiba Corporation.¹⁵¹⁶ Member companies are satisfied with their own phaseout progress. Thus

¹¹Examples of industry associations are the Air-Conditioning and Refrigeration Institute (ARI), the Air-Conditioning and Refrigeration Technology Institute (ARTI), Alternative Fluorocarbons Environmental Acceptability Study (AFEAS), UV Monitoring and Assessment Program/Panel (UMAPP); the Association of Fluorocarbon Consumers and Manufacturers (AFCAM), the European Phenolic Foam Association (EPFA), the Halon Alternatives Research Corporation (HARC), the Industry Cooperative for Ozone Layer Protection (ICOLP), the Program for Alternative Fluorocarbon Toxicity Testing (PAFT), and the Swedish Refrigeration Foundation.

¹³Also a member of JICOLP, the Japanese industry cooperative.

¹⁴Also a member of JICOLP, the Japanese industry cooperative.

¹⁵Also a member of JICOLP, the Japanese industry cooperative.

¹⁶Affiliate members are American Electronics Association, the Association for Research and Development of Industrial Processes, CANACINTRA (Mexico), Center for Global Change, Electronic Industries Association, Halogenated Solvents Industry Alliance, ITRI (Taiwan), the City of Irvine, California, the Japan Electrical Manufacturers Association (JEMA), Korea Anti-Pollution Movement, the Korea Specialty Chemical Industry Association, the National Academy of Engineering, the Research Triangle Institute, the Russian Institute of Applied Chemistry, the Russian Ministry of Environmental Protection & Natural Resources, the Swedish EPA (Naturvardsverket), the Technology Development, Building Official and Code Administrators, Center for Emissions Control, Commercial Refrigerator Manufacturers Association, Food Marketing Institute, General Aviation Manufacturers Association, halon Alternatives Research Corporation, Halong Recycling Corporation, Heating, Refrigerating, and Air Conditioning Institute of Canada, Institute of International Container Lessors, International Association of Refrigerated Warehouses, Mobile Air Conditioning Society, Mechanical Service Contractors Association, Ontario Refrigeration and Air Conditioning Contractors Association, Polyisocyanurate Insulation Manufacturers Association, Refrigeration Service Engineers Society, Southern Building Code Congress International and the Society of the Plastics Industry.

¹⁶Examples of NGOs in the Ozone Policy Network are Greenpeace, the World Wildlife Federation, and Friends of the Earth.¹⁶ Formal offices set up within this network include the two Secretariat offices (Nairobi, Montreal), regional ODS offices within the

their current contribution to the global problem reportedly stems from "good will" as the association members conduct technical ODS reduction projects in selected Article 5(1) countries (Morrill 1994). ICOLP Projects in Mexico, Malaysia, Turkey, Thailand have been completed; programs in India and China are scheduled for the end of 1994 (with Canadian bilateral contribution funds); and plans for a project in Brazil are being formulated. Most project funding derives from members' in-kind contributions; additional funds include a \$260,000 grant from the Multilateral Fund via the World Bank, and funds from Canadian and American bilateral contributions.

E. The Ozone Product Network

The *Ozone Product Network* is more likely driven by commercial dealings and a focus on technical matters and specific industrial interests. Members are individual companies, essentially substitute and technology consumers, and households as consumers of ODS friendly products. Within the manufacturing and service companies diversity abounds. For example within the refrigerant sector three tiers, each having different information needs, have been recognized:

Many individual manufacturers are impacted by information relating to the replacement of CFCs. Some companies may not even be aware that they are affected. The obvious companies are those directly involved in manufacturing refrigerant and equipment, and those that provide components to these industries. These companies have many ways of obtaining the data they need. A second tier of companies is associated with industries that incorporate refrigeration, air conditioning, and heat pump equipment into their product line including vehicle manufacturers, residential, commercial, and industrial builders, process designers in all major industries, stores and transport companies. A third tier of companies is represented by the service industry that repairs, maintains, and replaces equipment. Information flow to these second and third tier companies is not always straightforward and extra efforts have to be made to ensure that they receive the information that they need" (UNEP 1994c: pp. 14: 20-21).

F. Evaluation of Four Networks in the ODS Phaseout: Lessons Learned

The four networks that have been briefly described here and the overarching Global Ozone Community are, of course, more rich, and more complex in reality than this brief description can capture. Members bridge networks, cross industrial sectors, and span global regions. Over time the complexity increases. In other words, these comprise a growing, dynamic, emergent social system of communication and information exchange that changes in its capacity to share information and in the types of information it needs to share. Each network has made a contribution to solving the ODS problem, even though a major part of the past few years has been spent in institution building.¹⁷ Now that an information

Foundation of Turkey, the Turkish Ministry of Environment, the United Nations Environment Programme, the United States Air Force and the US Environmental Protection Agency.

¹⁷The Executive Committee reports that 37 Article 5(1) countries have received institutional strengthening funds ranging from US \$41,250 to US \$450,000. Institutional

infrastructure has been created, improvements in the social organization of information exchange are possible.

In order to improve the system of information exchange, better stock needs to be taken to evaluate what has worked and what hasn't. Better coordination within and among each of these networks would be ideal, especially since, as described earlier, the original implementing agency mandates have shifted over time. The first step in evaluating the production and delivery of information helpful to the phaseout may be for the Ozone Program Network to organize the wealth of information now available, reinforce the original idea of a clearinghouse for information flow, determine the variety of information needs and appropriate responses, and agree on directions for information exchange in the future. Toward that end the following observations are made:

Actors have been so pressed to act quickly that reflection, evaluation, and communication of results have often been left to chance. All four networks should be encouraged to share experiences, knowledge, procedures through an ozone information clearinghouse as originally conceived by the Ozone Policy Network. Now that the communication infrastructure has been built, improvements in the clearinghouse function can be designed.

There is a problem of awareness of the information materials that have been prepared. That is, even when experiences have been documented and would be helpful to others, potential users may be unaware that such documents and reports are available. Comprehensive, up-to-date, accessible lists of agency and industry publications need to be made available in a timely and user-friendly fashion.

The types of information that are helpful vary widely and change constantly. There is information embedded in particular products or technologies, general technical manuals, reports of scientific and technological breakthroughs; and descriptions of organizational procedures. The information needs of various actors throughout the industries and governments united in the phaseout process are also diversifying. Information messages and channels must keep pace with the changing information needs of relevant actors. The amount of information available regarding ODS and the global response is now overwhelming. The ability to identify, organize, retrieve and use pertinent scientific and technical information is critical for effective and speedy behavior change.

Capacity to access the mounting information also varies. The Ozone Program Network must work for users with electronic sophistication and technology as well as for those without. Getting on Internet¹⁸ and having Internet carry titles and abstracts

strengthening refers to projects for collecting and processing data and information "to fulfil[sic] the national information exchange obligations as a Party to the Protocol." (See UNEP 1994: UNEP/OzL.Pro/ExCom/13/43, p. 5).

¹⁸Internet is a global system of electronic communication carried by telephone lines and satellite connections and accessed through computer linkages. INFOTERRA is an information node established by the United Nations to carry environmental information.

of pertinent "gray" information (as opposed to peer reviewed journal articles e.g.) and successful phaseout stories may be one possibility. Linking databases via Internet (perhaps INFOTERRA) should be part of the province of the OzonAction Information Clearinghouse. Yet, the great variance in country capacity for computer networking suggests that hard copy materials and diskettes (and listings of their existence¹⁹) are still very important.

The information clearinghouse function assigned to UNEP IE/PAC is extremely important in principle. In practice, the office needs greater support for data base combination and translation if it is to accomplish the goal of being an up-to-date repository and locus of dissemination of the ever-expanding wealth of scientific, technological and organizational information.²⁰ Problems of inaccurate, false, or misleading information have to be surmounted; here increased reliance on an expert editorial board is encouraged.

The needs of Article 5(1) countries regarding the nature and volume of ODS information remain especially acute as they compete with other pressing national problems and with fewer resources. Resource inequalities, language differences and cultural chasms must be bridged. So too must the tendency for unidirectional information flows. Instead regional linkages with local expertise need creative support.

One information exchange mandate, Article 7's requirement that Parties report production, consumption, and trade of controlled substances to the Secretariat has not been less than adequately fulfilled. This has been difficult for many countries, partly due to the changes required in the Harmonized Commodity System and partly due to the lack of trained personnel and logistical support to monitor the flow of substances.²¹ Despite an increasing amount of information relating to ODS, incomplete reporting of

¹⁹See for example UNEP's "Protecting the Ozone Layer: Publications Available from the OzonAction Programme.

²⁰Regarding information exchange, UNEP reports learning that there is a wide range of queries that come from very broad-user sectors, that necessary up-to-date data are difficult to collect, dissemination costs are very high; information providers are generally product or service providers so there is a need for quality review of the information provided; and hands-on experience regarding available information is desirable. As for its training and networking activities UNEP has learned that it needs to develop an integrated and comprehensive training strategy. In addition smaller compatible groups allow easier identification of needs and difficulties in implementation and training courses that last a minimum of 4 days and that include practical training are ideal (see UNEP 1993a).

²¹The Ozone Secretariat reviewed the reporting of data by the Parties at the 8th Meeting of the Implementation Committee. It reported that as of May 1994, there are significant problems with underreporting. Seven non-Article-5(1) parties and 35 Article 5(1) parties had not reported baseline data for 1986; six non-Article 5(1) parties and 17 Article 5(1) parties had not reported baseline data for 1989 and only 44 out of 88 parties had reported data for 1992 (OzonAction, July 1994).

production and trade data is particularly frustrating to the implementation process. The Ozone Policy Network has taken up this problem to determine reporting barriers and to discuss actions that will encourage full compliance. (See for example, UNEP 1994b.)

Local or regional exchange via face-to-face communication between socially similar people dedicated to ODS phaseout should be encouraged. In such exchanges meanings can be more easily shared, the trust that facilitates acceptance of change is likely to grow, and mutual learning is likely to occur (Rogers 1983). Identifying and sponsoring particularly effective local actors is recommended. It has not always been the case that National Ozone Offices have been effective in supporting these relationships at the local level. This is a critical task of the National Ozone Units. Their other important task is to provide the link with the global information structure, coordinated through an improved UNEP IE/PAC. Hopefully as the Ozone Program Network evaluates itself and builds consensus on information responsibilities, the role of the National Ozone Units will be better articulated for more effective cooperation.

Public awareness programs will continue to be important partly to provide individuals with information to change their own behaviors²² and partly to create the public support for industrial responsibility and government accountability.

²²A standard stage model of the relationship between information and behavior change begins with general knowledge that changing behavior is desirable. The stages are pre-contemplation; information reception; contemplation; set for action; action; maintenance.

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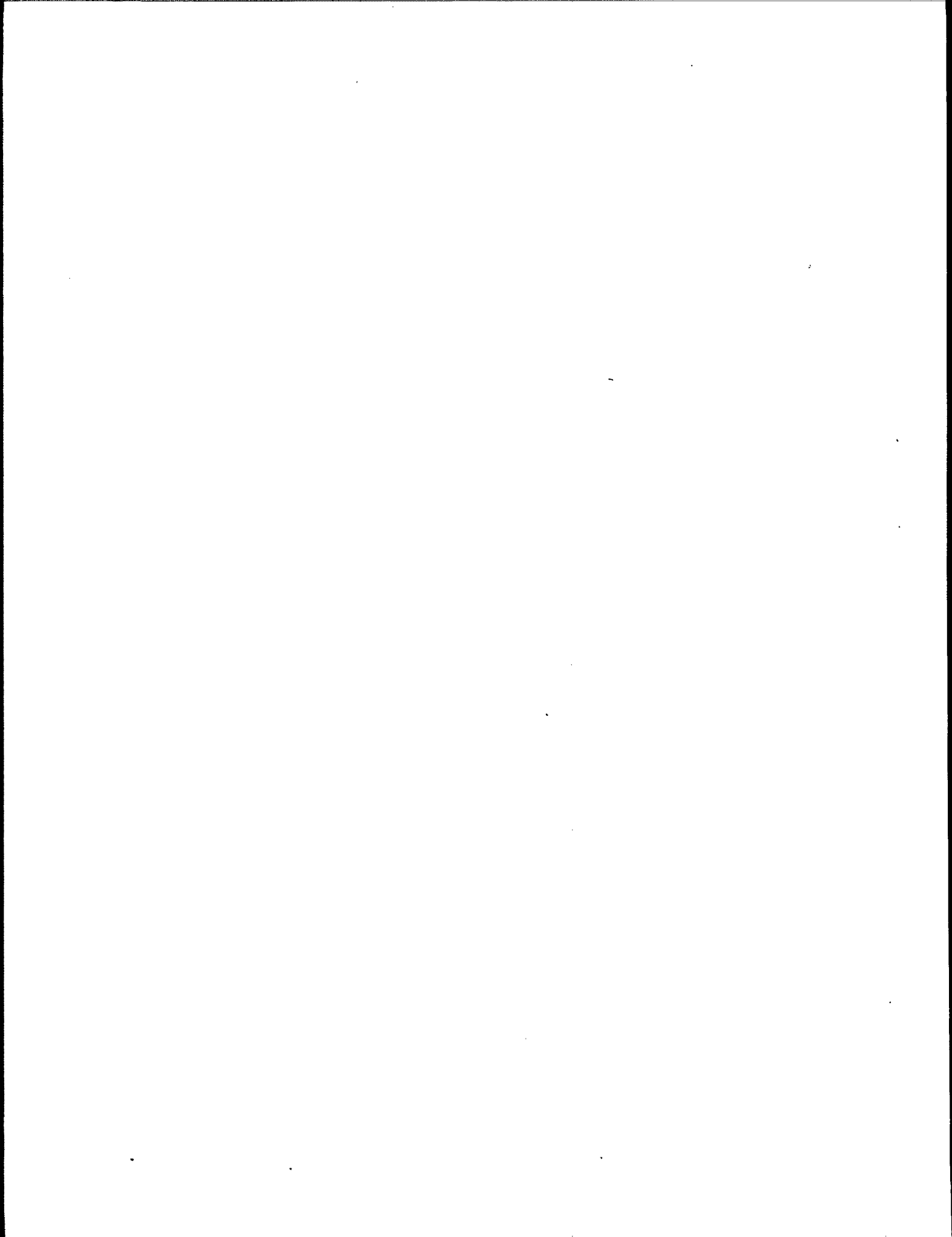
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CHAPTER 6

INTERNATIONAL TRADE ISSUES

I INTRODUCTION

Trade issues arise in relation to the Montreal Protocol because of: (a) specific restrictions in trade between signatories and non-signatories and (b) differences in phaseout provision between Article 5(1) countries¹ and other signatories.

This chapter examines both sets of concerns. Section 2 looks at the trade restrictions as embodied in Article 4 of the Protocol, which regulates trade between Parties and non-Parties. It begins by examining the rationale for placing such restrictions and evaluates the success they have had in meeting their intended role. The compatibility of the restrictions, however, is being discussed in the GATT; hence issues of GATT compatibility are also reviewed. The restrictions under the Protocol are being implemented progressively. From bans on imports of controlled substances from non-Parties, the Protocol went on to ban exports from Parties to non-Parties and is now reviewing the feasibility of banning trade between Parties and non-Parties in goods "produced with but not containing" controlled substances. The practicability of such a ban, as well as its desirability are discussed in this section.

Section 3 examines the effects of a slower phaseout for Article 5(1) countries on the production and trade between such countries and other countries. In particular there is a concern over the possible shift in production to Article 5(1) countries from the developed countries required to phaseout most ODSs by 1995. How valid is this concern, and what measures, if any, should be undertaken to limit such movements of capital are discussed in this section. Finally, Section 4 concludes the chapter.

II TRADE RESTRICTIONS BETWEEN PARTIES AND NON-PARTIES

Under Article 4 of the Montreal Protocol, trade between Parties and non-Parties is heavily restricted. The Article instructs Parties to ban the import of the controlled substances in Annexes A and B² from non-Parties within a year of entry into force of the Protocol (1st January 1990). Similarly, exports from Parties to non-Parties are required to be banned after 1st January 1993. The restrictions apply not only to trade in ODSs but also to trade in commodities containing ODSs. A list of such products was to have been prepared within three years of entry into force of the Protocol, and a list was presented at the Bangkok Meeting in November 1993.

¹ These are countries broadly classified as "developing" but more accurately they are those with a per capita consumption of ozone depleting substances (ODSs) of less than 0.3kg at the date of entry into force or at any time thereafter, until January 1 1999.

² A list of the substances under each annex is given in Appendix One to this chapter.

The exceptions to these rules are those non-Party states which have demonstrated compliance with the regulations laid down in Articles 2, 2A to E, 2G and Article 4, by providing data as specified in Article 7. These Articles are the ones that effectively specify the phaseout schedule for the different controlled substances. Hence the exception is basically to allow for the possibility that some countries are not signatories but are in compliance with the terms of the Protocol³.

In November 1992, at Copenhagen, the Fourth Meeting of the parties made some further amendments to article 4. These were as follows: Within a year of the entry into force of the Copenhagen Amendment, Parties are required to ban the imports or exports of controlled substances in Group II of Annex C (Hydrobromoflourocarbons) from or to any state not party to the Protocol.

In the 1991 version of the Handbook to the Montreal Protocol, there is an addition made to Article 4, with reference to trade in goods "produced with but not containing" the controlled substances in Annexes A and B. No clear cut rules were laid down, as of the 1991 meeting, but it was recognized that this was an issue to be dealt with.

"By 1 January 1994, the Parties shall determine the feasibility of banning or restricting, from states not party to this Protocol, the import of products produces with, but not containing, controlled substances in Annex A. If determined feasible, the Parties shall, following the procedures in Article 10 of the Convention, elaborate in an annex, a list of such products. Parties that have not objected to the annex, in accordance with those procedures shall ban, within one year of the annex having become effective, the import of those products from any state not party to this Protocol." (UNEP, 1991).

Products produced with, but not containing, substances from Annex B are similarly treated, the difference being that the time frame being considered is slightly longer, namely 5 years. In the 1992 Amendment, products produced with but not containing substances from Annex C are subjected to a similar scrutiny, the time frame being 5 years from the date of entry force of the Amendment.

By 30th September 1991, 80 countries had either ratified or acceded to the Protocol. The main exceptions at that stage were: Bolivia, Botswana, Dominican Republic, El Salvador, Iraq, Morocco, Pakistan, Paraguay, Turkey and Zimbabwe. By the Fifth Meeting of the Parties to the Protocol in Bangkok in November 1993, Botswana, Pakistan, Turkey and Zimbabwe had become Parties. The Republic of Korea was still classified as not being a party, although according to UNEP records it became a member of the Protocol in February 1992 (perhaps it had not officially ratified the treaty by the time of the Bangkok meeting)⁴.

³ Thus in 1993 countries such as Malta, Jordan, Poland and Turkey requested exemption from the trade sanctions on the grounds that they were in compliance with Articles 2 although they had not ratified the London Amendments to the Protocol.

⁴ See *Business Korea*, June 1992, Cover Story

Thus although there are several small countries that are not Parties to the Protocol, the number of significant consumers not within the Protocol are very few (Bolivia, Iraq, Mongolia, Morocco and North Korea are the only exceptions; and Afghanistan, Angola, Burundi, Congo, Eritrea, Ethiopia, Laos, Lesotho, Madagascar, Nepal, Rwanda, Somalia and Zaire are large countries but small CFC users that have not signed). In the case of Morocco, the non ratification was simply a legal mistake and will be corrected soon. As of June 1994 137 countries had ratified the treaty. A full list of 71 non- signatories is given in Appendix 3 of this Chapter.

The purpose of the restrictions on trade with non-Parties was precisely to encourage them to become Parties to the Protocol. From the evidence it appears to have been a successful strategy, although there were other factors that played a part. Among these was the financial package offered to the Article 5(1) countries at the London Meeting of the Protocol in June 1990, to cover the incremental costs of meeting the terms of the Protocol, as well as the grace period of ten years for the same countries to achieve the same degree of phase-out as the developed countries. The relative importance of the roles of the different inducements to countries to become Parties of the Protocol are difficult to disentangle. Certainly the financial package played an important part, as major users and potential users of ODSs (such as India and China) stated that they would not accede to the Protocol in the absence of such a package. However, the trade restrictions also played a part. In the case of a country such as The Republic of Korea signing the Protocol was delayed as long as possible because: (a) although it might have benefitted from the financial assistance covering the incremental costs, it believed that such assistance would not be enough (the fund was limited in size). It estimated, for example that it would cost the Korean industry about \$1.9 bn. to operate within the restricted consumption of ODSs⁵. Since the total fund set up to assist Article 5.1 countries was only \$260 mn for the period 1991-1993, Korea was not expecting to meet its incremental costs from that source. In any event, the Fifth Meeting of the Parties took the view that the Republic of Korea could not be classified as an Article 5.1 country as its consumption of ODSs was in excess of 0.3 kg per capita by that time (November 1993).

Had countries such as The Republic of Korea stayed outside the Protocol, they could not have acquired ODSs from Parties as of January 1993. In 1990 the country was importing about 9300 tons of CFCs, or 48 percent of total consumption. However, that was down from 64 percent the year before. At the same time, Korea reduced its total ODS consumption between the two years by nearly 30 per cent. Thus the country was both reducing overall consumption at the same time as increasing domestic production in the early years of the Protocol. There are indications that domestic production in 1991 rose even more sharply (by 44 percent from the previous year)⁶. If Korea could, over a short period, produce all the ODSs it needed, why then did it decide to join the Protocol? Apart from the diplomatic pressure, one reason could be the fact that the Protocol restricted imports of products

⁵ The estimate is almost certainly an exaggeration of the true cost and is based on the lost value of production if no substitutes are available. Nevertheless it shows how large a cost Korea perceived with entry into the Protocol would entail.

⁶ All figures are from *Business Korea*, June 1992

containing ODSs from non-Parties and many of the commodities manufactured in Korea such as air conditioners, refrigerators etc are exported to countries that are Parties. Another was the prospect that the Parties might ban trade in products "made with but not containing" ODSs. The latter would, of course, have a very major impact on a open economy such as Korea, that relies so heavily on international trade. Thus the threat of trading restrictions probably played an important part in Korea's decision to seek membership of the Protocol.

What about the countries that have not sought membership? There are a number of possibilities that could explain their strategy. One is that they will seek to declare the trade restriction illegal and thereby avoid having to pay the price of phasing out controlled substances over the relatively short period that is available under the Protocol. However, given that most of them are small users/producers, and such action entails significant costs, this is unlikely to be an explanation. Another is that they are not major importers of controlled substances, nor do they exports products containing controlled substances. With relatively closed economies they may find it more convenient to continue using the ODSs and phase them out when the substitutes are in fact cheaper. However, restrictions on imports will be costly, especially if equipment such as refrigeration units, that need CFCs to service them, cannot be made available. Furthermore, the closed economy argument is difficult to accept if the Parties place restrictions on products made with but not containing ODSs. In that event almost all countries would find it too costly to remain outside the Protocol. Finally, there is the simple fact that some of these countries are in a state of transition or of poor government, and have not realized the consequences of not signing the Protocol and its amendments. This must be an important factor in countries such as Angola, Congo, Rwanda, Somalia and Zaire; and of a number of former CIS states.

A. Challenging the Applicability of the Trade Restrictions.

It has been suggested that the trade restrictions such as those discussed above are invalid under the terms of the GATT (Sorsa, 1992). A distinction has to be made between provisions of the Montreal Protocol that apply to Parties and those that apply to non-Parties. Parties could, in principle waive their GATT obligations in relation to the Protocol thus making the trade restrictions consistent with the GATT. However, the same does not hold if the restrictions are applied to non-Parties which are members of the GATT; it could be held to violate the Most Favored Nation Principle of the GATT, by which all members of that agreement should be treated alike with respect to trade rules. In this case there are three options. Before considering these it should be noted, however, that to date no cases have been brought before the GATT challenging the validity of the trade restrictions.

One justification is to invoke Article XX of the GATT, which does allow for trade restrictions to meet public policy objectives in the environmental (or other) spheres if the same objectives cannot be met by less distortionary policies. It also requires (a) that the measures taken must be "necessary" for meeting the policy objective and/or "related to" the conservation of natural resources and (b) applied in a non-discriminatory way. In relation to the Montreal Protocol, Article XX would probably permit discrimination as a last resort measure. However, whether the trade restrictions are necessary or whether there are less distortionary policies available for meeting the same objectives remains unclear. It has been argued that, as the Protocol is drafted in terms of reducing the consumption of ODSs rather than their emissions to the atmosphere, the same reductions could be achieved at lower cost

through the use of more efficient instruments in countries that are Parties to the Protocol than through trade sanctions on "free riders". This is probably true *ex post* (because there are so few free riders), but that may be because the threat of trade sanctions has brought so many countries into the Protocol. It is impossible to resolve such a debate on economic grounds.

It can be argued, however, that, were a case to be brought before the GATT against the trade restrictions component of the Montreal Protocol, the view that the sanctions were not necessary at the present time would prevail.

A second option is for all GATT-contracting Parties to waive their rights under that agreement on a case by case basis. However, if some countries have not been willing to sign the Montreal Protocol, it is unlikely that they will be willing to waive their rights under the GATT for the same Protocol.

Finally there is the option that GATT be amended to address such environmental concerns. This may appear desirable in the case of the Montreal Protocol, but could have the effect of encouraging the use of trade policies for environmental purposes in a wide variety of cases, and may encourage protectionism by that route (See Markandya, 1994). It has been decided to transform the Trade and Environment Working Group of the GATT into an Interim Committee, to be continued once the WTO is ratified. Agreement has already been reached that its agenda include a review of the consistency of the GATT with international environmental agreements.

B. Extending Trade Restrictions to Products 'Made With But Not Containing' ODS

As described earlier, in 1991 an addition was made to Article 4 of the Protocol, requiring Parties to "determine the feasibility of banning or restricting" the imports for products made with but not containing controlled substances in Annexes A, B and C (see Appendix 1 for a list). The time frame for the different substances was such that Annex A substances were to be banned within one year of a decision that such a ban was feasible, and Annex B and Annex C substances were to be banned within five years of such a decision.

The Technology and Economic Assessment Panel (TEAP) examined the feasibility of sanctioning trade in products made with but not containing controlled substances. They focused on the question of whether it was practically feasible to identify such products. If ODSs had been used in the manufacture of a product, trace residues would be present and could be screened for in the field using portable gas chromatography. Laboratory confirmation could use GC-Mass spectrometry. However, there are no internationally accepted testing protocols to detect such residues and there is no threshold value of residue that defines "made with" (UNEP, 1993B).

Although it is possible to establish such procedures for some products there are several for which it is not. Examples of the latter given by the TEAP include solvents in the manufacture of electronic products, mould release agents in the manufacture of plastic products and drugs. Even if sophisticated tests could be devised, they would not be economically feasible to carry out. Because virtually every product in trade could have some component that was manufactured using a controlled substance, the range of products to be tested would be enormous, and one could not use a product code or other simplifying practice for customs authorities.

These arguments appear to be very strong reasons for not attempting to control products not containing but made with controlled substances. The economic and legal arguments reinforce these. The first issue to be settled from an economic viewpoint is to determine what constitutes "made with". Given the interrelationships between different sectors of the economy (as summarized in a country's input-output matrix for example), one could argue that all products exported from a non-Party were made using ODSs either directly or indirectly. Thus the measure would be tantamount to banning almost all exports from non-Parties. Given the previous discussion about the conflicts between the GATT and such trade sanctions, a measure of this severity could not be upheld in the present GATT.⁷ The costs on a non-Party would be far in excess of the benefits in terms of reduced ODS production. A less stringent interpretation would be to look only at the direct input of ODSs in the production of goods. Thus far, no inventory has been prepared of products that would fall into this category and what percentage of total exports of non-Parties they would constitute. Particularly affected would be electronics products and others where ODSs are used for cleaning or as solvents. Given the small amount of use of ODSs in these processes, the cost in terms of loss of trade benefit would appear to be very high, relative to the gains in terms of reduced productions of the controlled substances. It could be argued, for example, that a bigger saving in consumption could be achieved by increasing the incentives for ODS Banking (see Chapter 7), and at less cost.

One possibility that has been discussed, which would avoid the objections raised above is for countries to provide "self-certification" about the use of ODSs in the production processes of affected goods. Since such a procedure could result in big inter-country differences in certification, guidelines on how each country would award the certificates would have to be laid down and respected. However, any such guidelines would run into precisely the problems that have been identified above. Hence this proposal faces the same difficulties as other methods of dealing with this issue.

At the Fifth Meeting of the Parties to the Protocol, in Bangkok in November 1993, the whole question of a ban on such products was debated. The view was taken that such a ban was not feasible at this stage but that the Technology and Economic Assessment Panel should review this issue at regular intervals.

C. Trade in Controlled Substances and the Basel Convention on the Transboundary Movement of Hazardous Wastes and Their Disposal.

At the Fifth Meeting of the Parties, the implications of the Basel Convention for the international movement of the wastes of containing substances controlled by the Protocol was also raised. The revised Basel Convention toughens the regulations on the international movement of hazardous wastes. Exemptions, however, are allowed for the export of those

⁷Ban on products made with but not containing controlled substances would be in conflict with the GATT from another perspective as well. This is the stipulation that countries not use process standards in allowing entry to products. Process standards specify how a product was made -- in this case using ODSs -- whereas product standards define the final product only -- eg. whether it contains ODSs.

substances where it can be shown that a superior technology for their disposal or recycling is available in the importing country.

In the case of ODSs, the Basel Convention would allow the shipment of substances in cases where it could be demonstrated that they were being recovered from products that contained them, and then either being recycled or disposed of safely. Such trades could be an important part of an efficient phaseout solution and it would be a mistake if the Basel Convention prevented them. It is quite likely that, in the near future, a substantial market will develop in recycled ODSs (see Chapter 7) with demand coming from countries that decide to maintain ODS-using equipment with remaining economic life-times and the supply of recovered ODSs coming from countries that are switching out of ODS-using equipment. In principle, such trades should be possible with the use in the importing country being classified as "recycling", but the Basel Convention wording on this is vague and needs to be clarified.

One area where trade is controlled in substances which are not being recycled is halons. The balance between supply and demand of the present stock is uneven enough for trade to be beneficial. Again, a ban on such trade as a result of the Basel Convention would be detrimental to achieving the goals of the Montreal Protocol at least cost. The Bangkok Meeting agreed to submit a resolution to the Parties of the Basel Convention to that effect.

D. Recycling of Controlled Substances and Illegal Trade.

The validity of the above arguments is seriously weakened by the fact that there appears to be a growing trade in illegal shipment of ODSs. Some countries have substantial production capacity, particularly those in Eastern Europe. At the same time the demand for ODSs from small users in developed countries (and in some developing countries) is not declining as fast as was expected. Thus there is a market for these products as countries, such as those in the European Union, are phasing out their production and legal importation.

For such imports to come into the country they can be disguised as materials for recycling. False documentation makes this possible and there is a concern that this is being practised widely, although there are no figures available. At the Tenth Meeting of the Open Ended Working Group of the Parties to the Montreal Protocol in July 1994 the US representative suggested that :

"consideration should be given to a decision to ensure...that substances being imported or exported as used or recycled materials were indeed used or recycled.... Exempting such imports or exports from the calculation of consumption might have unwittingly created a loophole in the Protocol Regime." (UNEP, 1994)

More recently an ICI executive, speaking at a British Association press conference said that illegal CFCs were flooding into Europe, most likely from Eastern Europe and Asia. He stated that:

"The big high-profile users have switched to CFC substitution not only for public relations but because they want to be up with the new technology. The 'black market' relies on large numbers of small CFC users who do not want

to make changes in their equipment to use the substitute chemicals. And CFCs still cost only half as much as the substitutes." *Financial Times*, September 8 1994.

This is a serious issue which needs to be addressed, the first step being to verify the figures for prices and the level of 'black market' demand. The problem can be handled partly by tightening the checks on exports of recycled materials, but it can also be approached from the exporters' end by monitoring production at the CFC plants more carefully. Both of these monitoring operations should be possible. It would be a pity if trade in recycled ODSs were to be banned because the necessary actions to control illegal trade were not implemented.

III. TRADE AND CAPITAL MOVEMENTS RELATED TO ODS.

Because Article 5(1) countries have a longer period over which to phaseout ozone depleting substances, it has been argued that developed countries may move their production facilities for goods that use ODSs to these countries so as to take advantage of the less stringent phaseout schedules. There is virtually no evidence available for such a shift in production is taken place; moreover the lack of such evidence is consistent with most other findings on industrial location. The decision of where to locate a production facility involves a number of factors, including the cost of labor, access to markets, social and political conditions in the country concerned, the infrastructure facilities in the country concerned and the regulatory framework. The last includes environmental regulations but again they are only part of the full set of regulations. Considerable evidence exists to the effect that investors look not only at current regulations but also at the stability of the regulatory framework (how frequently governments change the rules).

To evaluate whether firms locate in countries to take advantage of less stringent environmental regulations it is necessary to assess carefully the quantitative importance of the different factors that determine location decisions. Studies of multinational corporations have shown that these decisions are most influenced by such factors as labor costs, access to markets and the existence of a developed industrial base (Wheeler and Mody, 1992). Factors such as environmental regulations and corporate tax rates emerge as less important. At a more statistical level, an analysis has been carried out of the direct foreign investment by pollution intensive industries in developing countries to see if such investment has been increasing faster than direct foreign investment in general. Between 1973 and 1985 direct investment in the chemical and mineral industries as a percentage of direct foreign investment in all manufacturing industries rose from 25.7 percent to 26.5 percent (Leonard, 1988). Similarly, a study of majority owned affiliates of OECD-based companies in developing countries does show that those involved in pollution intensive industries did increase their investment slightly faster than did all manufacturing industries (Jaffe et al, 1993). This statistical evidence is only weak support of the pollution-migration hypothesis as it does not point to any significant change in investment patterns. What is observed could be explained by other factors such as the changing structural pattern of demand in the developing countries themselves.

More recent studies have supported these findings. Dean (1990) in a comprehensive survey of studies published up to 1990 concludes that there is little evidence of industrial

relocation because of differences in environmental regulations. Grossman and Krueger (1992) analyze the *maquiladora* program (which permitted US firms to locate on the Mexican side of the US-Mexico border on advantageous terms) and find that pollution abatement costs were not a significant determinant of the trade generated by the program.

Even when pollution intensive industries do locate in developing countries, they do not necessarily adopt a minimalist approach in terms of meeting environmental regulations. Often corporate policy dictates the use of the same technology and pollution controls in all foreign countries where plants are located as in the home country (subject to, of course, meeting the local standards where the latter are more strict). This is partly in response to their public image of which they are very conscious, and partly in recognition of the fact that regulations are almost certain to become more strict in the developing countries, and preemptive action may well be cost effective (Jaffe et al, 1993). Thus it would be surprising to find that major multinationals were locating in Article 5(1) countries to take advantage of their longer phaseout period for ODSs.

There are only two cases reported of a shift of industry as a result of differences in the ODS phaseout schedules. One was from China (Lu et al, 1993). This case study on trade and the environment cites the shift of a number of CFC-using enterprises from Hong Kong to Guandong Province in China. There are now over 20 such enterprises that have moved to Guandong Province; they use over 50 tons of CFCs. As a percentage of China's use of ODSs this is not a large amount and the reason for the shift is not clear. Since Hong Kong is treated as part of the United Kingdom in terms of the Protocol, it may be seeking to phaseout ODSs before 1997 when Hong Kong reverts to China, and therefore it may be advantageous to shift production to the mainland that has a less stringent phaseout schedule as an Article 5(1) country. However, it is also possible that the reason for the shift has more to do with access to the China market than to the longer phaseout period for the use of ODSs.

The second case is not of a redeployment in production facilities as such but of a shift in production between different facilities of the same enterprise. Thus, some firms may have closed down production of ODSs in developed countries whilst increasing production in developing or transitional countries. Evidence on this is not available on a systematic basis, but even if it is happening, it is not something that should necessarily be a matter of concern. Developing countries need ODSs for some time to come. A ban or restriction on such production shifts would simply raise the cost of obtaining the ODSs and of meeting the reduction targets on the part of the developing countries. The targets, of course, will be respected irrespective of whether such relocation of production is permitted or not.⁸

Finally it should be noted that for some fast growing developing countries, they are

⁸The one concern that has not been addressed in the above argument is that developing or transitional countries may succeed in exporting the increased trade of CFCs as recycled materials. The demand for ODSs is not falling as fast as was hoped in some developed countries. Hence there is a demand for contraband production. For the production of plants to evade the accounting of production of ODSs it would of course be necessary for the production to be mis-recorded as well as for the importation. The extent of this is unknown as was discussed above, but the matter needs further investigation.

reluctant to permit firms that use ODSs to enter and set up production in case, by doing so, they raise total consumption to over 0.3 kg/head. If this should happen, they would lose the benefits of being an Article 5(1) country. Malaysia, for example, has a level of consumption close to that limit and is reluctant to admit foreign companies that may raise increase domestic ODS consumption above the qualifying level. In this way, "industrial migration" is being restricted.

A. International Trade and Phaseout of ODSs.

The China study also demonstrates clearly the advantage for an export oriented economy to adopt the new non-ODS-using technologies as soon as possible. As a major manufacturer of refrigerators, air conditioners etc., China found that its export markets for these products collapsed after the introduction of the Montreal Protocol. The volume of refrigerators exported declined by 58 percent between 1988 and 1991 and similar declines were noted for other products. International buyers simply did not want to commit themselves to the purchase of equipment that would become obsolete in a few years time (when maintenance would become very difficult as ODS supplies become difficult to obtain)⁹. As much as anything else, it was this kind of data that convinced the Chinese authorities to accelerate their phaseout program; in fact, China committed itself to phaseout dates that are faster than the minimum permitted under the Protocol. A number of other Article 5(1) countries have done the same (e.g. Mexico). Table 1 below gives details of the accelerated phaseout schedules adopted by some other countries that are in excess of the Protocol's requirements.

IV. CONCLUSIONS.

This Chapter has examined the trade issues related to the Montreal Protocol. It began by looking at the trade sanctions against non-Parties. It was argued that these played an important part in encouraging countries to join the Protocol. Certainly, the evidence from Korea would support such a view. However, there were other factors at play and it is not clear what relative importance should be attributed to them (eg the financial assistance for Article 5(1) countries and the longer phaseout period). Certainly the Protocol has proved to be increasingly successful in getting countries to join. At the last count only a handful of significant users had not joined; they represent only a very small fraction of the total use of ODSs.

What can be done to bring these non-Parties into the fold? The use of stricter sanctions, such as restricting trade in products made with and not containing ODSs would probably be a mistake. Apart from the fact that it would be very difficult to implement, it could also raise difficult questions in the GATT. The threat of imposing such restrictions may have proved to be a very effective instrument, but actually trying to carry out that threat may show it to be an empty one.

⁹It is also possible that the decline in exports was due to the increased domestic demand for these goods, during a period of rapid economic growth. However, export decline of this magnitude, in a country that placed a premium on exports, was certainly a result of a decline in demand as well.

TABLE 1 EXAMPLES OF NATIONAL POLICIES MORE STRINGENT THAN THE MONTREAL PROTOCOL (Base 1986)

CFC PHASEOUT

	M.P.	EC ¹	Austria	Denmark	Finland	Germany	N'lands ²	Norway	Sweden	Switz.	U.S.
100%	07/89				12/90				01/89		
85%							01/91			12/92	01/91
80%											01/92
50%	01/95	01/92			12/92	01/92	01/92	01/91	01/91		
15%	01/97	07/93									
10%			01/93								
5%											
0%	01/00	12/95	01/95	12/95			01/95 12/95			12/94	

HALON PHASEOUT (Exemptions for essential use)

	M.P.	EC	Austria	Denmark	Finland	Germany	N'lands ⁵	Norway	Sweden	Switz.	U.S.
100%	01/92						01/92				
50%	01/95						01/93				
0%	01/00	12/95	01/91 ⁷	12/15	12/91	12/91 ⁹	01/95	01/95	01/98	12/91 ¹⁰	12/95

CFC - 113 SOLVENT PHASEOUT

	M.P.	EC	Austria	Denmark	Finland	Germany	N'lands ¹¹	Norway	Sweden	Switz.	U.S.
100%	07/98										
85%							01/91				01/91
80%											01/92
50%	01/95	01/92		01/92			01/92				
15%	01/97	07/95		07/95			07/95				
0%	01/00	12/95	01/94 ¹²	12/95	12/94	03/92 ¹⁴	12/95	07/91 ¹⁵	01/91 ¹⁶	01/93 ¹⁷	12/95

The most effective way of encouraging the remaining countries to join the Protocol is to demonstrate that they would gain security of access to existing ODS supplies that are required to service their ODS-using equipment, especially chillers and refrigeration. This argument could be reinforced by showing that those becoming Parties have not suffered serious losses and are in fact gaining from the adoption of the new technologies. It might be conducive to offer non-Parties the option of signing memoranda committing them to act as *de facto* Parties to the Protocol, until such time as they could ratify the Montreal Protocol. But if these measures do not succeed, one could leave the non-Parties to their own devices without significant consequences for the protection of the ozone layer. As long as the trade restrictions remain in place, their use of ODSs will be small and will be phased out eventually as the non-ODS technologies increasingly become world standards.

One area where restrictions in trade may be counterproductive is with regard to the Basel Convention. It was pointed out that transboundary movement in ODSs between the Parties could be important in meeting the terms of the Protocol at least cost. These could be permitted under the Basel Convention, which restricts the movement of hazardous wastes, but the issue needs to be clarified. The most serious complicating factor is the possibility that such trade could be a loophole for the illegal shipment of newly produced CFCs that are represented as recycled substances. There is some indication that this is happening and needs to be controlled. The matter requires early attention by the Parties. However, the preferred solution should not be to ban trade in products for recycling. Rather, it should be to enforce more effectively the trading rules and conditions.

The question of ODS-dumping was also addressed. Although in principle the incentive is there for a shift of production facilities between developed and developing countries, there is hardly any evidence for it. The issue of pollution-migration, has been studied in some depth and the evidence for such migration is very weak. Thus it would be surprising if it were to be significant in this case.

Annex A

CONTROLLED SUBSTANCES

Group	Substance	Ozone Depleting Potential*/
Group I		
CFCl_3	(CFC-11)	1.0
CF_2Cl_2	(CFC-12)	1.0
$\text{C}_2\text{F}_3\text{Cl}_3$	(CFC-113)	0.8
$\text{C}_2\text{F}_4\text{Cl}_2$	(CFC-114)	1.0
$\text{C}_2\text{F}_5\text{Cl}$	(CFC-115)	0.6
Group II		
CF_2BrCl	(halon-1211)	3.0
CF_3Br	(halon-1301)	10.0
$\text{C}_2\text{F}_4\text{Br}_2$	(halon-2402)	6.0 ³⁸

* / These ozone depleting potentials are estimates based on existing knowledge and will be reviewed and revised periodically.

Annex B

Controlled substances

Group	Substance	Ozone-depleting potential
Group I		
CF_3Cl	(CFC-13)	1.0
C_2FCl_3	(CFC-111)	1.0
$\text{C}_2\text{F}_2\text{Cl}_4$	(CFC-112)	1.0
C_3FCl_7	(CFC-211)	1.0
$\text{C}_3\text{F}_2\text{Cl}_6$	(CFC-212)	1.0
$\text{C}_3\text{F}_3\text{Cl}_5$	(CFC-213)	1.0
$\text{C}_3\text{F}_4\text{Cl}_4$	(CFC-214)	1.0
$\text{C}_3\text{F}_5\text{Cl}_3$	(CFC-215)	1.0
$\text{C}_3\text{F}_6\text{Cl}_2$	(CFC-216)	1.0
$\text{C}_3\text{F}_7\text{Cl}$	(CFC-217)	1.0
Group II		
CCl_4	carbon tetrachloride	1.1
Group III		
$\text{C}_2\text{H}_3\text{Cl}_3^*$	1,1,1-trichloroethane (methyl chloroform)	0.1

* This formula does not refer to 1,1,2-trichloroethane.

38. The First Meeting of the Parties decided in Dec./19 to accept the value for the Ozone Depleting Potential (ODP) for halon 2402, as 6.0, and to request the Secretariat to inform the Depositary that the Parties agreed to accept this figure by consensus at their First Meeting and that accordingly the Depositary should insert this figure to replace the words "to be determined" in Annex A to the Montreal Protocol.

1. The first part of the document is a list of names and addresses of the members of the committee.

Annex CTransitional substances

<u>Group</u>	<u>Substance</u>
<u>Group I</u>	
CHFCI ₂	(HCFC-21)
CHF ₂ Cl	(HCFC-22)
CH ₂ FCI	(HCFC-31)
C ₂ HFCI ₄	(HCFC-121)
C ₂ HF ₂ Cl ₃	(HCFC-122)
C ₂ HF ₃ Cl ₂	(HCFC-123)
C ₂ HF ₄ Cl	(HCFC-124)
C ₂ H ₂ FCI ₃	(HCFC-131)
C ₂ H ₂ F ₂ Cl ₂	(HCFC-132)
C ₂ H ₂ F ₃ Cl	(HCFC-133)
C ₂ H ₃ FCI ₂	(HCFC-141)
C ₂ H ₃ F ₂ Cl	(HCFC-142)
C ₂ H ₄ FCI	(HCFC-151)
C ₃ HFCI ₄	(HCFC-221)
C ₃ HF ₂ Cl ₃	(HCFC-222)
C ₃ HF ₃ Cl ₂	(HCFC-223)
C ₃ HF ₄ Cl	(HCFC-224)
C ₃ HF ₅ Cl	(HCFC-225)
C ₃ HF ₆ Cl	(HCFC-226)
C ₃ H ₂ FCI ₅	(HCFC-231)
C ₃ H ₂ F ₂ Cl ₄	(HCFC-232)
C ₃ H ₂ F ₃ Cl ₃	(HCFC-233)
C ₃ H ₂ F ₄ Cl ₂	(HCFC-234)
C ₃ H ₂ F ₅ Cl	(HCFC-235)
C ₃ H ₃ FCI ₄	(HCFC-241)
C ₃ H ₃ F ₂ Cl ₃	(HCFC-242)
C ₃ H ₃ F ₃ Cl ₂	(HCFC-243)
C ₃ H ₃ F ₄ Cl	(HCFC-244)
C ₃ H ₄ FCI ₃	(HCFC-251)
C ₃ H ₄ F ₂ Cl ₂	(HCFC-252)
C ₃ H ₄ F ₃ Cl	(HCFC-253)
C ₃ H ₅ FCI ₂	(HCFC-261)
C ₃ H ₅ F ₂ Cl	(HCFC-262)
C ₃ H ₆ FCI	(HCFC-271)

Appendix 2**UPDATE OF THE PHASEOUT SCHEDULES FOR ODSs IN ARTICLE 5(1) COUNTRIES**

The present phaseout schedule for consumption of ODSs in Article 5(1) countries is as follows:

Article 2A: Concerning CFC-11, CFC-12, CFC-113, CFC-114, CFC-115:

January 1 2005: not more than 50% of 1986 level
January 1 2007: not more than 15% of 1986 level
January 1 2010: complete phaseout

Article 2B: Concerning Halons 1211, 1301, 2402

January 1 2002: not more than 1986 level
January 1 2005: not more than 50% of 1986 level
January 1 2010: complete phaseout

Article 2C: Concerning CFC-13, CFC-111, CFC-112, CFC-211, CFC-212, CFC-213, CFC-214, CFC-215, CFC-216, CFC-217:

January 1 2003: not more than 80% of 1989 level
January 1 2007: not more than 15% of 1989 level
January 1 2010: complete phaseout

Article 2D: Concerning Carbon Tetrachloride

January 1 2005: not more than 15% of 1989 level
January 1 2010: complete phaseout

Article 2E: Concerning Methyl Chloroform

January 1 2003: not more than 1989 level
January 1 2005: not more than 70% of 1989 level
January 1 2010: not more than 30% of 1989 level
January 1 2015: complete phaseout

These schedules allow for a ten year grace period with respect to the targets applicable for those countries not operating under Article 5(1). In addition, the non-Article 5(1) countries are permitted exceed their production targets by 10-15% of their calculated level of production in 1986 in order to satisfy the basic domestic needs of the Article 5(1) countries.

Appendix 3

COUNTRIES AND TERRITORIES THAT ARE NOT SIGNATORIES TO THE MONTREAL PROTOCOL

Afghanistan	Korea, North	Tajikistan
Albania	Kyrgystan	Tonga
Angola		Turks and Caicos Islands
Anguilla	Laos	
Armenia	Latvia	Vanuatu
Azerbaijan	Lesotho	Virgin Islands
	Liberia	
Belize	Lithuania	Western Sahara
Bermuda		
Bhutan	Macau	
Bolivia	Macedonia	
Burma	Madagascar	Yemen
Burundi	Mali	
	Martinique	Zaire
Cambodia	Micronesia	
Cape Verde	Moldova	Taiwan (*)
Cayman Islands	Mongolia	acts <i>de facto</i> as a member
Comoros	Montserrat	
Congo	Mozambique	
Cook Islands		
	Nepal	
Djibouti	New Caledonia	
Eriteria	Oman	
Estonia		
Ethiopia	Puerto Rico	
Falkland Islands	Qatar	
Faroe Islands		
French Guiana	Reunion	
	Rwanda	
Georgia		
Greenland	Saint Helena	
Guinea-Bissau	Saint Pierre	
	Saint Vincent	
Haiti	Sao Tome and Principe	
	Serbia and Montenegro	
Iraq	Sierra Leone	
	Somalia	
	Suriname	
Kazakhstan		

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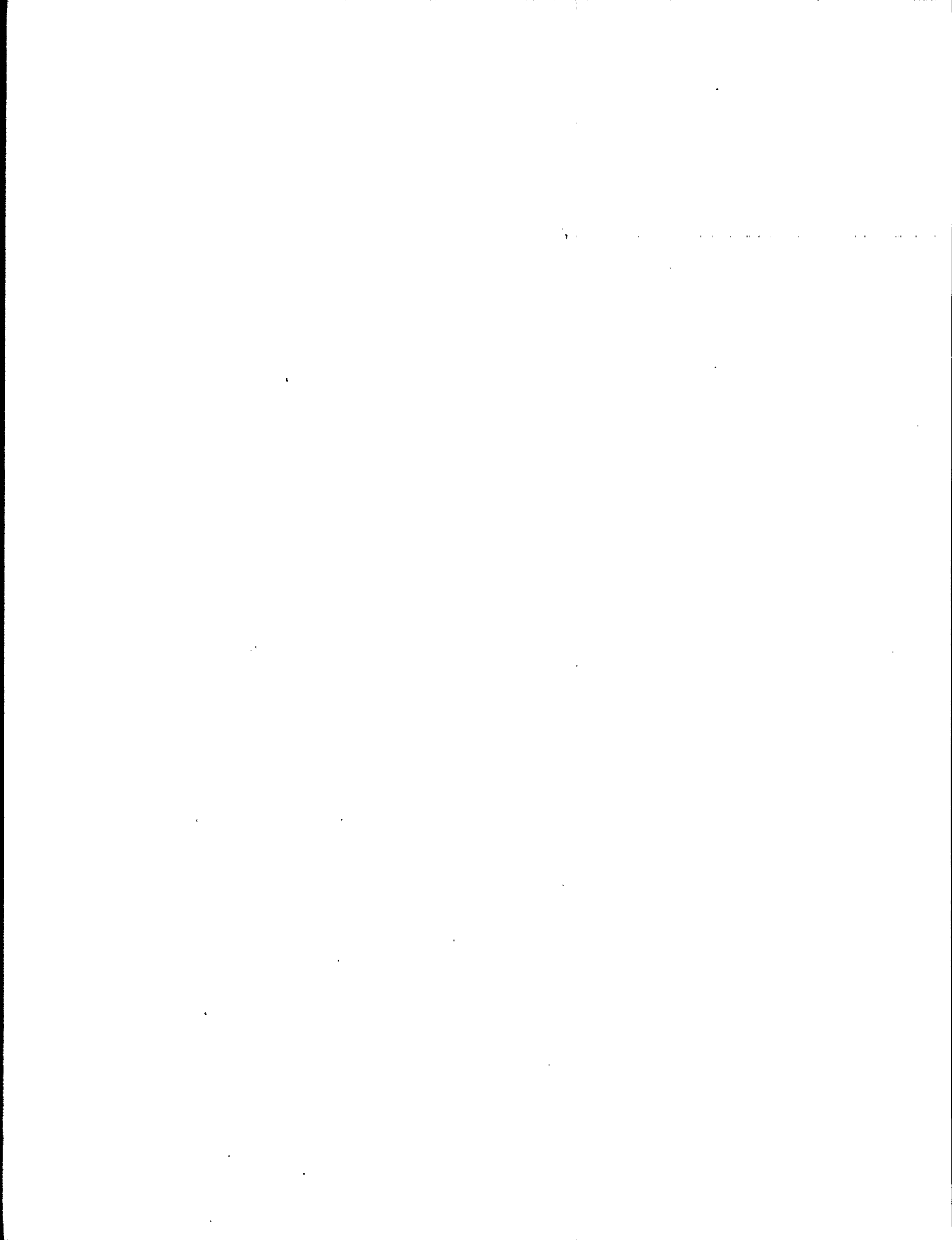
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CHAPTER 7

CFC AND HALON BANKING

I. INTRODUCTION.

Halon production ceased in non-Article 5(1) countries as of 1 January 1994. The current Protocol phaseout schedule calls for CFC production to end by 1 January 1996 in the non-Article 5(1) countries that account for the bulk of the world's output. These accelerated production phaseout dates have been dictated by the accumulation of scientific information on the extent and severity of stratospheric ozone depletion. Yet the accelerated schedule means that much equipment that was designed to use halons and CFCs---fire prevention and containment systems, stationary refrigeration and air conditioning equipment, automobiles, and the like---will have to be prematurely retired, retrofitted, serviced with "drop-in" substitutes, or serviced with banked and recycled ODSs.

The options selected in each case will be the result of a combination of economic and regulatory factors. The technology of retrofits is evolving, and the search for drop-in substitute chemicals continues. The outcome of this research is uncertain. It is impossible to know, for example, what the future cost of retrofitting mobile air conditioning systems will be. Nor can the future regulatory environment be known exactly. New evidence regarding the adverse effects of ozone depletion may lead to further tightening of the Montreal Protocol's timetable. In addition to these uncertainties, the Parties to the Protocol will have to decide whether to destroy the stocks of ODSs now in existence, and if so, when and how the destruction should be accomplished.¹

The end to production of ODSs requires those in the marketing chain to change their perspective fundamentally. Instead of dealing with a flow-dominated commodity---one whose production is continuous and for which inventories are a minor adjunct of marketing---users and wholesalers will deal with a stock-dominated commodity---one whose past production manifest in current inventories is what matters. Management of a stock-dominated commodity implicitly involves decisions about the timing of its use. A stock-dominated commodity exhibits the added complication that uncertainties about the future can be embodied in the current price. Just as everyone would like to buy such a commodity now to sell it for a higher price the next period, no one wants to be caught storing a commodity that soon will be worth much less.

1. Advice about this decision is outside the scope of the present *Report*. Suffice it to say that the decision will depend on (1) how serious is the additional damage to the ozone layer that would be caused by release or leakage of existing stocks of ODSs; (2) the cost and environmental impact of destruction technologies; and, (3) the loss in value of equipment that would no longer be operational if it could not be serviced by ODSs. While a number of destruction technologies have been examined (see below), "the current capacity of approved ODS destruction technologies cannot destroy the anticipated stockpiles of ODS within a reasonable time frame" (UNEP 1993c).

Both users and policy-makers rightly recognize that the remaining CFC production over 1994-95 would be used more sensibly if allocated over the rest of the decade rather than being consumed disproportionately during those two years. The total stockpile will be used more efficiently over time if the stocks go to the most valuable uses. It makes little sense for a U.S. automobile repair shop in 1998, say, to recharge the air-conditioning system of an old car having only a few years of useful life remaining, while a shortage of CFC inventory forces a supermarket owner to replace at great expense a set of relatively new refrigerators. Some current retrofits of air-conditioning systems, undertaken in part because of a worry over the future availability of CFCs, seem to be implicitly valuing the CFC at more than ten times its current price. A market among those holding CFCs, which gets the CFCs to the most valuable uses at the right time, can only improve the efficiency of the phaseout. Likewise, such trading will improve the time profile of the use of the remaining halons. In general, efficient management of stocks will, through the ordinary price mechanism, reduce the aggregate costs of the phaseout.

Besides saving the cost of premature replacement of specialized capital goods and durable consumer goods, efficient utilization of the existing stocks of ODSs unquestionably will reduce emissions, because users will have an incentive to avoid accidental release of a commodity for which others will pay. If the policy decision is later made to destroy what remains, emissions prior to that time will have been kept to a minimum. Efficient allocation over time can also assist the Article 5(1) countries in making their transition away from ODSs. These developing countries are concerned that they have adequate supplies of CFCs and halons during the 10-year grace period. If they feel too insecure about supplies, they may be induced to increase production during the interim period, thereby increasing the total amount of chlorine and bromine that will find its way to the stratosphere. Careful use of the current stock therefore can reduce cumulative global production and emissions of ODSs.

The efficient intertemporal allocation of stocks of ODSs has come, in some circles, to be referred to as "banking." Others use the term "banking" to refer to the collective saving of some of the remaining CFC production for use over the following years. Those working with halons have taken the term "banking" one step further, to refer to the mechanism for trading among users who have stored halons, such as a clearinghouse or a notice board for interested buyers and sellers. Some wholesalers of CFCs have begun using the term "banking" in its most literal sense: they have begun accepting deposits of CFCs from their customers, which they store together and release again by a bookkeeping entry. All these meanings of "banking" are reasonable---provided one is careful to be clear about which meaning is being used in a particular context. In addition, all these meanings of "banking" emphasize that something is being held in store. Together they make clear that the physical allocation over time of the ODS stocks depends on the particular pricing and trading systems devised.

II. THE EVOLUTION OF ODS BANKING.

In reviewing the experiences to date with ODS stock management, it is important to distinguish efforts involving halons from those involving CFCs. At least 13 countries have

already set up working halon banking operations. The halon production phaseout has already occurred in the non-Article 5(1) countries, and no "essential use" exemptions (as defined at the 1992 Copenhagen meeting of the Parties) were granted at the Fifth Meeting of the Parties in Bangkok in 1993. Although some users may request exemptions in subsequent years, the Halon Technical Options Committee has the view that existing stocks will be adequate, even for halon applications for which no substitutes are currently available (UNEP 1993a). Hence halons are already being treated like a non-renewable resource. CFCs are just beginning that transition, and not surprisingly, the stockpiling and marketing institutions are more rudimentary. However, the incipient marketing systems for CFC stockpiles and the resulting institutions may become more sophisticated than those evolving for halons.

The careful management of stocks of ODSs derives first from their scarcity giving them a higher current price. In addition to this price-level effect, there is every reason to believe that ODS prices will show as of any one time a pattern or "spread" among different delivery dates reflecting the market's anticipation of supplies and demand over time. Such price spreads exist for every other stock-dominated commodity for which there are organized markets. (Futures markets convey intertemporal signals of this type as of one moment in time, which is the main purpose of those markets.) Just as prices at different locations or prices for various uses signal a shipment or reassignment to the highest value application, the prices for different delivery dates signal the best time to consume a commodity. It may well be that the relative scarcity of an ODS increases over time, with the result that prices increase with later delivery dates. Nothing, however, precludes prices falling with time, as would happen if equipment were retired more quickly than the ODS is lost to the atmosphere. Such signals of the price of current or nearby use commanding a premium over the price for later use are observed in almost every commodity market at one time or another. It is possible that halons could follow the first pattern of increasing prices while CFCs eventually follow the pattern of prices falling with time to delivery. Whatever the actual pattern, either in anticipation or in the event, there is no reason to suppose halons and CFCs will behave identically.

A. Halon Banking.

Descriptions of the various national banking systems have been laid out in the July 1993 *Report of the Technology and Economic Assessment Panel* (UNEP 1993a). In addition, the UNEP Industry and Environment Programme Activity Centre (UNEP IE/PAC) publishes (and updates on a monthly basis) a *Halon Banking Sourcebook*. This reference contains a description of UNEP IE/PAC's International Recycled Halon Bank Management Information Clearinghouse, material from the July 1993 *Report* referred to above, a table showing the quantity of recycled halons available through national banking schemes, names and telephone numbers of contact persons for the existing banks, and brochures describing the various halon banks (UNEP 1993d). It would be redundant to repeat this material here. Instead, we can put some of these activities into an economic perspective.

Among the countries that have already set up halon banks, namely Australia, Canada, Denmark, France, India, Japan, Malaysia, The Netherlands, Russia, Sweden, Switzerland, the United Kingdom, and the United States of America (UNEP 1993d), a number of different

tendencies can be identified. Some of the countries, such as Switzerland, the United States, and the United Kingdom, have seen the emergence of institutions that perform essentially a clearinghouse role. (See Brunner and Covelli (1992) for Switzerland.) These halon information centers serve the function of bringing potential buyers and sellers together, nothing more. They do not serve as a market in the traditional sense, because price negotiations take place directly between the buyers and sellers, outside the context of the clearinghouse. In some cases, the larger users and holders of halon seek each other out and transact without going through the clearinghouse at all. Organizers of the clearinghouses in both the United States and the United Kingdom seem to be wary of running afoul of their countries' competition (anti-trust) laws. In the United States, this fear has deterred the main clearinghouse from allowing assessment of "critical" uses to be a mechanism to balance supply and demand, and in both the U.S. and the U.K. the clearinghouses avoid including any pricing information (Catchpole 1993; UNEP 1993a). Although price-setting discussions might, in some circumstances, provide a mechanism for anti-competitive collusion, it is difficult to see why such possibilities should inhibit the market-making activity of halon clearinghouses. After all, the organized commodities and futures markets in the United States and United Kingdom, where continuous auctions take place in trading pits in full view of everyone, are among the most competitive markets in the world. Why should it be different with halons?

In some countries, including Australia and The Netherlands, the halon banks hold physical stocks of the materials (UNEP 1993d). In the United States, the Department of Defense (DoD) has offered to collect unwanted halons from the private sector to add to its stockpile. This offer was motivated by the DoD's perception that it lacked sufficient halon-1301 to meet its projected needs, and to counteract the temptation of halon distributors to vent their stocks before the very sizeable "floor tax" (see below) went into effect on 1 January 1994 (Zurer 1993). A number of the larger servicing companies can be considered banks in this sense, as they hold the stocks of an entire client industry, such as the airline industry. Friends of the Earth, an NGO, has instituted its own program of halon recovery, with an aim of establishing a "network of regional banks throughout the country...to store the halon that is collected through this national campaign." This program "rests upon the premise that we must make every effort to recover halons and insure that the halons going back out into the marketplace are used for essential purposes only" (Gilfillan 1994).

In only one or two instances do these central stockpiles keep the stocks in the names of individual customers, using bookkeeping entries to record the deposit or to make any transfer. Nor do these central stockpiles facilitate any arrangements by which one party can use another party's holdings in the event of an emergency, with the promise to return at a later date the quantity of halons withdrawn. Large organizations with their individual stockpiles let their various subsidiaries use a central reserve for emergencies, as when a particular oil platform needs halons to replace quickly those just used for fire suppression; the central reserve replaces its own holdings without the urgency (and so at less cost). So far no system has emerged to share reserves across organizations (although several large companies have tried to work out arrangements with the U.S. Department of Defense that would permit the DoD to call on their stockpiles during wartime). Such fragmentation makes the whole storage system more costly than it needs to be.

B. CFC Banking.

1. History of CFC Prices.

With the increase in the price of CFCs (including tax) from under \$1/pound to over \$6/pound, the incentive to reclaim CFCs has increased greatly. Figure 7.1 shows *pre-tax* list prices for CFC-11, CFC-12, and CFC-113 in the United States, on a monthly basis from the beginning of 1986 (over a year before the Protocol was signed) through July 1994. Note that the list prices including the excise tax could be calculated from the prices shown in Figure 7.1 by adding the taxes shown in Table 7.3 below. The pattern of these prices would not change substantially if they were converted into constant dollars using a Producer Price Index, because inflation has been slight over this period.²

The price incentive is enhanced even more by the preferential tax treatment given to recycled CFCs, which are not subject to either the excise or inventory taxes imposed on newly-produced CFCs. Of course, all CFCs are supposed to be recovered if possible; releases to the atmosphere should only occur as the result of accidents, as when a compressor on an industrial chiller fails or a vehicle's air conditioning system develops a leak. The frequency of such accidents, however, responds partially to price. The owner of a large commercial chiller, fearing the leakage of \$10,000 worth of CFCs should the system fail, might decide to replace a working compressor as it nears the end of its projected life. More importantly, as the price of CFCs rises, the incentive to detect and repair leaks increases. When CFCs were inexpensive, the rational choice might have been to defer maintenance of a system until it failed. At the extreme of very high prices, not much CFC would be allowed to leak.

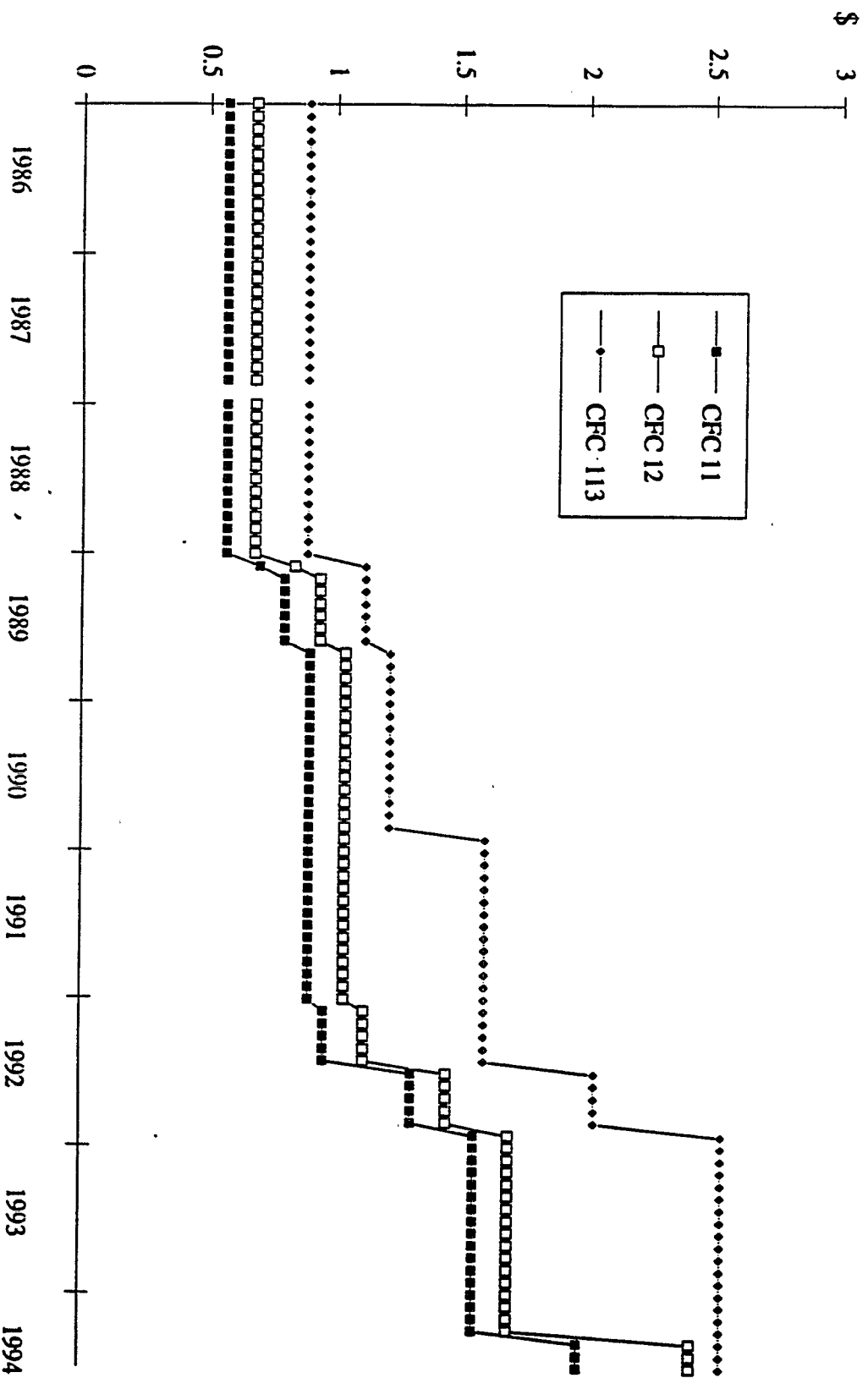
2. CFC Availability for Servicing Depends on Economic Incentives.

The extent to which the CFCs currently held in existing equipment can be conserved (by reducing leakage), recaptured (by retiring equipment from service or retrofitting it to use non-ODS fluids), and recycled is critical to maintaining availability of CFCs to service the remaining equipment. These relationships are illustrated by the calculations summarized in Tables 7.1 and 7.2. These two tables show the availability of CFC-11 and CFC-12 over time under certain assumptions regarding leakage, retrofit, and recovery rates. (The sources, definitions, assumptions, and calculations underlying Tables 7.1 and 7.2 are given in Appendix A to this Chapter.)

It should be emphasized that these Tables are designed primarily to show how CFC availability is sensitive to economic factors determining the behavior of equipment owners and potential reclaimer/recyclers. The estimates are not meant to be definitive forecasts; the

2. It should be noted that the first jump in the price, occurring in February 1989, may be slightly exaggerated. The *Chemical Marketing Reporter* listed two prices prior to that date, and the lower of the two is the one shown in Figure 7.1. Beginning in February of 1989, only one price for each CFC is reported. The price in February 1989 was greater than the higher of the two prices reported previously, however, so the list price did increase at that time.

Figure 7.1 - Pre-tax CFC List Prices, \$/pound



Source: Chemical Marketing Reporter, various dates.

O D S:		CFC-11								Production:	
Equipment type:	Commercial Chillers									In 1994	In 1995
Equipment life:	30									25000	0
Initial CFC stock:	61000										
Leakage rate:	0.08										
Retrofit rate:	0.02										
Recovery rate:	0.7										
Year	In Use	Retired	From Retrofits	Net Recycled	Service Needs	Available					
1994	61000	1993	1220	2249	4880	22369					
1995	57787	1953	1156	2176	4623	19922					
1996	54679	1914	1094	2105	4374	17653					
1997	51671	1875	1033	2036	4134	15555					
1998	48763	1838	975	1969	3901	13623					
1999	45949	1801	919	1904	3676	11852					
2000	43229	1765	865	1841	3458	10234					
2001	40599	1730	812	1779	3248	8766					
2002	38057	1695	761	1720	3045	7440					
2003	35601	1661	712	1661	2848	6254					
2004	33228	1628	665	1605	2658	5200					
2005	30935	1596	619	1550	2475	4276					
2006	28721	1564	574	1497	2298	3475					
2007	26583	1532	532	1445	2127	2793					
2008	24518	1502	490	1394	1961	2226					
2009	22526	1472	451	1346	1802	1769					
2010	20604	1442	412	1298	1648	1419					
2011	18750	1413	375	1252	1500	1171					
2012	16961	1385	339	1207	1357	1021					
2013	15237	1357	305	1164	1219	966					
2014	13575	1330	271	1121	1086	1001					
2015	11973	1304	239	1080	958	1123					
2016	10430	1278	209	1040	834	1329					
2017	8943	1252	179	1002	715	1616					
2018	7513	1227	150	964	601	1979					
2019	6135	1203	123	928	491	2416					
2020	4810	1178	96	892	385	2923					

Source: See text.

Table 7.2 - Potential CFC-12 Usage and Availability, Metric Tonnes

O D S:	CFC-12		Domestic Refrig.	Commercial Refrig.	Net Recycled	Net Production:	
	Equipment type:	Mobile A/Cs				In 1994	In 1995
	Equipment life:	14	20	20		155000	139000
	Initial CFC stock:	250000	150000	31000			
	Leakage rate:	0.20	0.03	0.24			
	Retrofit rate:	0.03	0.00	0.04			
	Recovery rate:	0.50	0.00	0.70			
Year	In Use	Retired	From Retrofits			Service Needs	Available
1994	431000	18512	6820		9462	52863	111599
1995	406114	18452	6003		8989	47147	212442
1996	372582	18395	5229		8542	41724	179259
1997	339992	18340	4498		8119	36583	150795
1998	308386	18002	3720		7532	31710	126618
1999	274987	17674	3154		7059	26533	107143
2000	245631	17357	2539		6567	22721	90989
2001	218024	17050	1958		6099	18583	78505
2002	191441	15319	1411		4937	14667	68775
2003	165854	16464	897		5231	10965	63040
2004	142378	16184	412		4829	7467	60402
2005	118459	15914	356		4646	4162	60886
2006	95086	15652	304		4471	3623	61734
2007	74901	15398	255		4303	3107	62930
2008	57275	8340	210		735	2610	61055
2009	41701	8307	168		682	2133	59604
2010	33226	8274	129		632	1674	58562
2011	24823	8243	93		585	1233	57915
2012	16487	8214	59		541	807	57649
2013	8214	8185	29		500	396	57753
2014	0	0	0		0	0	57753
2015	0	0	0		0	0	57753
2016	0	0	0		0	0	57753
2017	0	0	0		0	0	57753
2018	0	0	0		0	0	57753
2019	0	0	0		0	0	57753
2020	0	0	0		0	0	57753

Source: See text.

categories are very broad and are not broken down according to the sizes of different classes of (for example) commercial chillers; nor are the production figures for 1994 and 1995 known exactly. The equipment categories also include machinery using blends, and the breakdown across equipment according to CFC type (11 or 12) is not as sharp as that shown in the Tables. In addition, the calculations do not incorporate possible continued production of CFCs in the Article 5(1) countries during the Protocol grace period, nor do they reflect Article 5(1) demand arising from potential new production of ODS-using equipment.³ Exact forecasting of the actual amount of the different CFCs that will be available world-wide over time is beyond the scope and resources of this Committee.⁴

Despite these caveats, the calculations shown in Tables 7.1 and 7.2 are illustrative of the critical importance of economic incentives. Depending on the leakage, retrofit, and recovery parameters, it is possible to project either adequate supplies of CFC for servicing, or shortages. In both tables, the amount of CFC in use is computed from estimates of the number of units of different types of equipment installed worldwide. Depending on the lifetime of the units, a certain percentage are retired each year. At the same time, a fraction of the CFC-using units are retrofitted in each year. The recovery rate specifies how much of the CFC contained in the retired and retrofitted units is reclaimed and made reusable, and this annual amount is shown as "net recycled." Service needs are based on annual replacement of the leakage from each type of equipment. In the case of mobile air conditioners (MACs), it is assumed that no servicing or retrofitting of the systems is done during the last three years of their lives. Finally, the available CFC is computed as the sum of stored production (from 1994 and 1995) plus net recycled CFC, minus the annual service need.

The two tables show that, under plausible behavioral assumptions, there could be sufficient CFCs to service existing equipment. But two essential points must be stressed: (1) the availability of CFCs for service depends on successful recovery and recycling of CFCs in existing equipment, and (2) the key parameters of the calculation---the leakage, retrofit, and recovery rates---depend on the incentives that will prevail at the time decisions are made regarding the disposition of equipment and the CFC it contains. A breakdown in the recovery and recycling effort will lead to large increases in the price of CFCs or, if prices are controlled, to shortages.

In the case of CFC-12 shown in Table 7.2, the total quantity available depends strongly on the rate of leakage from mobile air conditioning systems and the fraction of the CFC-12 that is recovered when vehicles are scrapped. If the leakage rate is substantially below the 0.20 value assumed in Table 7.2, CFC-12 would be abundant over the next 25 years. The leakage parameter indeed could be well below the 0.20 rate. Sophisticated hand-held equipment now

3. The needs and production capacities of Article 5(1) Parties are addressed by the Executive Committee of the Interim Multilateral Fund for the Implementation of the Montreal Protocol (1992a and 1992b).

4. It should be noted that even the most detailed forecasts can rapidly be rendered obsolete by events. The 1991 *Report of the Refrigeration, Air Conditioning and Heat Pumps Technical Options Committee* (UNEP 1991) prepared careful forecasts of CFC demand and availability for all the refrigeration subsectors. Yet the assumptions underlying these projections regarding the speed of the changeover (as driven by subsequent modifications of the Protocol) were too conservative.

exists that can detect minute concentrations of CFC-12 leaking from mobile air conditioners, and this equipment is available in certified MAC repair shops. It would be a relatively simple matter for a check of an automobile's air conditioning system to become part of routine maintenance. Yet if the leakage rate from automobiles is not 0.20 but 0.25 (the high end of the range estimated for the U.S. fleet) and the other parameters are unchanged, availability of CFC-12 runs out beginning in the year 2003. Similarly, if the calculation is modified so that leaking CFC-12 is replaced over the entire lifetime of the vehicles (instead of assuming that A/C systems are not serviced during the last three years of the vehicles' lives), the margin of surplus available CFC-12 after about 2005 becomes razor-thin (less than 7,000 tonnes, and less than 2,000 tonnes after 2010). If there is no retrofitting or recovery of CFC-12 from MACs when vehicles are scrapped, the CFC-12 available for servicing runs out after 2001 and the cumulative deficit is nearly 40,000 tonnes. If actual production during 1994 and 1995 were to be only 20% less than that estimated in Table 7.2, the surplus of CFC-12 would turn negative after 2009.

Similarly, in the case of CFC-11 a tradeoff exists between the leakage rate and the retrofit rate. According to Table 7.1, a deficit of CFC-11 is avoided because retrofits provide a cumulative 15,576 tonnes, a large fraction of the initial stock of 25,000 tonnes not already in equipment. By implication, if the leakage rate is in fact much higher than that assumed in Table 7.1, a very high number of retrofits (or retirements) will be required to keep the remaining equipment operating. On the other hand, if investments in reducing leaks, say through improved monitoring equipment, can reduce the leakage rate, fewer retrofits would be necessary. Such reductions are technically possible; the question is whether they make sense given the prices for CFC-11, retrofits, and monitoring equipment.

It would have been possible to imagine a situation in which there was so much CFC on hand from the production occurring in 1994 and 1995 that servicing the available equipment would be no problem. At the other extreme, it might have been obvious that servicing needs will be so large that no amount of recovery and recycling would be adequate. The actual situation, as demonstrated by the size of the availability margin and by the sensitivity analysis showing that this margin can turn positive or negative with small (and plausible) changes in the underlying parameters, demonstrates that the economic incentives for recovery and recycling are crucial for maintaining the existing CFC-using equipment. In addition, the models that yield the estimates of Tables 7.1 and 7.2 are based on the presumption that CFCs can flow to the sectors and locations where they are needed, or, in other words, that trade remains free and that CFC banking and reclaiming operations are successfully established. The economic cost of the CFC phaseout (excluding its environmental benefits) will be much larger than it needs to be if recycling and banking are inadequate.

Another way of seeing the potential sufficiency of the CFC stock for servicing existing equipment can be developed, in the case of the United States, from data compiled by the Congressional Research Service (which is also relied on partially in Appendix A to construct the estimates used in Tables 7.1 and 7.2). According to the CRS, the total amount of CFC required for servicing in the United States between 1996 and 2005 is between 200 million and 400 million pounds. The CRS also estimates that 1994 and 1995 U.S. production could be as high as 270

million pounds (based on U.S. CFC production allowances),⁵ and that 410 million pounds of CFCs are presently contained in U.S. equipment. If all existing CFC-using equipment is retrofitted or discarded by 2005 (this allows existing automobiles to live out a 10-12 year lifespan), the CRS estimates that 680 million pounds of CFCs would be available to meet the servicing need of 200-400 million pounds (Gushee 1993). Under these assumptions, servicing demand can be met if the stock is managed intelligently.

The effect of the level of prices already seems to be operating in the market for CFCs. An increasing number of reclaimers are advising preventive maintenance. Much refrigerant is being recycled because of regulatory stipulations as well; recovery of some types of CFCs from junked equipment is now required by law in the United States (*Global Environmental Change Report* 1994c). CFC recovery will also be influenced by the price of the material. Similarly, the decision to retrofit a large piece of CFC-using capital equipment will depend on the price and anticipated future availability of CFCs, as well as on the capital cost of the retrofit investment. Both retrofitting and recycling will be encouraged by a high price for CFCs, and this price incentive will, in turn, help assure that existing equipment will be maintainable after the CFC production ban goes into effect. For all these reasons, the effective stock of CFCs includes all CFCs now installed in any system. Quite apart from the advantages of an improved allocation of the last production from 1994-95, a market in inventories would improve the intertemporal allocation of refrigerants already installed. Policies should be put into effect that support the normal operation of economic incentives.⁶

The effect of intertemporal price spreads is harder to observe so far. For a flow-dominated commodity, the price remains more or less steady year after year, as new production can absorb any changes in demand. If CFCs were to continue to be produced, anyone reclaiming them would receive roughly the same price whether the reclaiming was done this year or next. Such conditions may not prevail under the new regime for CFCs. For one thing, CFCs will become worthless once the installed base of equipment using them has been retired or retrofitted. At that time, the use value of any remaining CFCs will be zero. In the year before demand disappears, the CFCs would still bear a positive price. The intertemporal spread between the prices at two dates is a signal to reclaim CFCs earlier rather than later. This price advantage to earlier reclaiming may not offset other reasons for delay, but it does provide an incentive to speed up conversions.

5. The actual U.S. production allowance for 1994 and 1995 is larger than the production projected by the CRS. The U.S. is allowed to produce 25% of its 1986 Protocol baseline of 328,760 metric tonnes (UNEP 1993b). This is approximately 180 million pounds per year, or 360 million pounds for 1994 and 1995. The CRS production estimate assumed that the U.S. would produce only 15% of its 1986 baseline in 1995 (Gushee 1993).

6. Examples of how strongly price can influence commodity recovery and recycling can be found in diverse markets. One case is that of the silver market in early 1980. Compared to the year before, the price of silver bullion had increased by a factor of eight. Suddenly, many dentists were investigating ways of saving their used x-ray film to redeem the silver. Many individuals with a few coins in the back of a dresser drawer thought to take them to dealers. Best estimates place the amount of silver "reclaimed" for commercial use to have been on the order of 100 million troy ounces, equal to about 1/4 of commercial bullion stocks and 1/3 of annual worldwide production. This price increase in silver lasted only a few months; had it been more permanent, the total amount reclaimed would have been even larger. As it was, many of the procedures for reclaiming silver from x-rays became standard practice (Williams, in press).

An important implication of the idea of the intertemporal price spread is that it is not necessarily a problem if visible CFC inventories are consumed quickly. For example, at currently prevailing price levels, owners of large-scale refrigerant systems such as commercial building air conditioners and supermarket refrigerators may find it advantageous to reclaim almost all their CFCs, recycling continuously, while a larger fraction of CFCs used to service mobile air conditioners comes from the remaining virgin production. This pattern of usage would correspond to a price pattern in which CFCs would be relatively expensive until the point when the present CFC-using fleet of cars has effectively been retired, with lower CFC prices thereafter.

Of course, the inventories held in different sectors respond to factors other than the level and intertemporal pattern of CFC prices. In some industries, the full opportunity cost of holding CFCs (or of a shortage) may not be observable because the firms do not conduct market transactions in CFCs. Other motivations can be important as well. For example, automobile manufacturers are stockpiling supplies of CFC-12 to service vehicles under warranty. Auto makers' investments in customer loyalty and brand name capital are considerable, and part of maintaining that investment may be the strategic decision to give car owners the choice of a higher-priced 134a retrofit or a lower-priced CFC recharge when they have their air conditioners serviced.

For any commodity with an organized market that has been studied, which ranges from corn to frozen pork bellies, from shell eggs to heating oil, aggregate visible inventories respond closely to the relevant intertemporal price differentials. (This relationship was first noticed by Working for wheat (1933); he called it "the supply-of-storage curve" (1948, 1949).) Actually, it would be more accurate to say that the amount in inventories and the intertemporal price spread jointly determine one another. The same should be true for CFCs were the market to become well organized. Even as the price level influences the amount of recycling and the intertemporal price spread influences the timing of the recycling, the quantity recycled and the timing of recycling influence the price level and price spread. Something that would change the cost of retrofitting or something that would change the cost of storage would alter all the quantities, usage profiles, and prices.

3. CFC Banking and Loan Markets.

The larger the quantity of a commodity that is reclaimed or recycled, the more often someone who buys it will later want to resell it. A purchase followed by a subsequent resale involves two sets of transactions costs, such as brokerage fees, negotiating expenses, search time, etc. A purchase followed by a later resale amounts to having temporary possession of the commodity. Temporary possession can also be achieved by a loan. A loan, however, requires only a single negotiation. If this single transaction is even slightly more convenient than the sum of two regular buy/sell transactions, many parties in the market will prefer to arrange loans rather than sales.

Any number of commodities have developed formal lending arrangements. For example, silver dealers lease, usually for one year, bullion to chemical firms, who use it as a catalyst and so have it to return. Recently, a gold lending market has developed, based in London, involving an amount of gold on the order of one year's worldwide production (*Financial Times* 24 March 1994). The lease rates on gold, which are reported daily in the *Financial Times*, have varied over the last few years from 1% to 5% per annum (payable in dollars, not gold). The main borrowers in this market have been mining firms, who need funds to develop gold deposits. They borrow gold, usually from a Central Bank, sell the gold and use the proceeds to develop the mine, then use the mine's output to return the gold to the lender. By doing this they reduce their risk from fluctuations in the price of gold.

An even more interesting example is uranium. Utilities operating nuclear power plants regularly borrow and lend uranium, although less so now than in the early 1980s. A utility that finds itself needing to replace its fuel rods earlier than expected and another utility that finds itself needing to shut down for extended maintenance arrange for a loan over the interim (even up to 5 years). These loans are easy to arrange, because the utilities do not store the uranium individually but in a central depository, which transfers uranium by book entry. Sufficient interest in these loans has existed for a brokerage firm, Nuclear Exchange Corporation (NUEXCO), to specialize in arranging them. Part of the negotiation is over what NUEXCO calls the "use charge," the fee the borrower pays for the loan. The use charge for uranium has moved up and down with the availability of loanable uranium, ranging from 1% to 10% per annum of the value of the uranium. This use charge includes both the ordinary rate of interest and the intertemporal price spread (Williams 1986, pp. 56-57).

Remarkably, the CFC market is showing signs of this type of commodity lending and borrowing. Several large wholesalers and reclaimers report that they are keeping on their premises the supplies of a number of large customers, who have recovered CFCs from some of their operations and may have later need of the CFCs elsewhere among their facilities. (The wholesalers and reclaimers have also purified the recovered CFCs.) The customers' inventories are not segregated but stored together in one warehouse and recorded simply as a bookkeeping entry. The firms involved call the customers' inventories "deposits" and the whole system "banking," as indeed it is. So far the "banks" have not begun to practice fractional reserve banking, which means keeping less in the warehouse than the sum of deposits outstanding, although at least one wholesaler has thought about it.⁷ Nor have they begun to arrange loans between their customers, though that would be a natural extension of the service they are offering.

Anything that would encourage the emerging loan market in CFCs would improve efficiency in the use of those CFCs. Although private trade is spontaneously creating such an institution, the success of loan markets often depends on other features such as the speed of enforcing contracts, the contractual provisions in case one party wants to extend the loan, and the ease of confirming that the appropriate quantities and qualities have been returned. Outside

7. Soon after grain warehouses in Chicago began in the 1850s to store grain in bulk and issue interchangeable warehouse receipts, they discovered fractional reserve banking, which was later halted by state intervention (Williams 1984).

intervention, for example with the creation of a standard loan form similar to that used for some other commodities, might speed the development of this marketing form.

The loan markets for silver, gold, platinum, and grain developed because the commodities were fungible. Indeed, the standardization of those commodities was helpful to the development of more conventional buy/sell markets. Fortunately, halons and CFCs are also highly fungible. Once purified, reclaimed CFCs are essentially indistinguishable from virgin product. The presence of trace contaminants seems relatively unimportant. CFCs do not need to be distinguished by age because they do not deteriorate in storage. Storage itself is relatively simple and inexpensive: cylinders on pallets in a warehouse, at a fee (currently quoted) of \$ 0.01 to \$ 0.02 per pound per month, with little fuss in placing or taking the cylinders from storage. (Grain warehouses, in contrast, must turn the grain frequently to prevent spoilage, and incur costs comparable to three months' storage expenses to elevate or unload the grain.) In addition, the costs of transporting CFCs are low as a percentage of value, which means that CFCs in a large geographic area are interchangeable.

Considering that wholesalers and reclaimers are already holding deposits for some customers and that the commodity is fungible, the private sector, at least in the United States, is well on the way to having a functioning intertemporal pricing system for CFCs. The tendencies are there for regional storage centers to develop. These centralized reserves would make supplies much more accessible to those who might need them in an emergency, as when a large chiller fails, and would allow a much more sensible collective allocation. The wholesalers and reclaimers are the natural overseers of such regional storage centers, as the centers would be adjuncts of their regular business. Indeed, their business might alter to providing an intermediary service between customers who might want to borrow or lend, and buy or sell, CFCs. The wholesalers could also trade on their own account, as when they have an opportunity to buy CFCs from a building slated for retrofit or demolition, or an opportunity to sign a guaranteed service contract for several years. Because they are unlikely ever to own more than a small fraction of the total amount of regional CFCs in use, the wholesalers will not have market power despite their central position. Further, the more they are encouraged to make public information about prices and stocks, the more all parties can trade and arrange loans on comparable terms.

III. INCENTIVES AND BARRIERS TO BANKING.

A. Taxes.

Tax policies regarding ODSs must strike a delicate balance. On the one hand, given the impending scarcity of ODSs being brought about by the Protocol's phaseout schedule, it is a legitimate objective of tax policy to see to it that holders of ODSs are not recipients of windfall profits (Gabel 1994). In addition to equity concerns, the existence of large windfall profits could blunt the incentive of ODS holders to speed the adoption of substitute technologies, particularly if the ODS holders are also manufacturers of replacement chemicals (DeCanio 1988).

On the other hand, a schedule of taxes that is too steep will have the effect of cutting back ODS use even faster than the projected phaseout program. Taxes that are too high can undermine the objective of promoting a rational phaseout timetable. The problem of fixing tax rates that will mesh with other policy instruments is further complicated by the fact that demand for ODSs is shifting along with supply; as users make the changeover to alternative technologies, the downward shift in demand will to some degree match the cutback in supply mandated by the regulations. This makes price forecasting problematic. It would not have been an easy task to forecast the price of any of the major CFCs over the past few years, because the pace of substitution has been surprisingly fast (see Chapter 1 above). The countries that currently tax ODSs include the United States and Denmark.

The most important impact of ODS taxes, however, is their effect on the incentive to recover and recycle ODSs. By guaranteeing that users will have to pay a high price for newly produced CFCs, tax policy can greatly increase the likelihood that a functioning market in recycled material will develop. A tax on virgin ODSs, whether produced domestically or overseas, can make recycled ODSs, which are not taxed, economically attractive to users, while at the same time enabling reclaimers and recyclers to realize a profit despite the costs they must incur to purify and store the ODSs they collect.

The ODS tax policies of the United States illustrate some of the ways such taxes can interact with banking. In the U.S., the taxes on "new" ODSs increase over time. In addition, the United States has also adopted a "floor tax." This is a tax on ODS inventories held for sale or further manufacture that is equal to the amount by which the excise tax on new ODSs increases each year. The floor tax has the effect of imposing the same tax on an ODS as would be in effect in the year the ODS is sold, regardless of when it was first purchased (U.S. Treasury, Internal Revenue Service 1991).

Table 7.3 shows the past, current, and projected rates of tax on some of the major ODSs in the United States. For 1996 and later years, the base tax rate is scheduled to increase by \$ 0.45 per year. There is currently no tax on domestically recycled ODSs, although recycled imports are being taxed in an effort to control illegally mislabeled CFCs shipped into the United States (see below).

The differential tax treatment of new and recycled ODS is important in maintaining the economic attractiveness of recycled material. However, as shown in Section II-B above, efficient handling of the transition depends on careful management of the remaining production that will take place between now and the end of 1995. It is appropriate to tax this final output in order to establish recycling markets as rapidly as possible.

Table 7.3

U.S. Excise and Floor Taxes on Selected ODSs, 1990-1995, \$/pound

Year	CFC-11		CFC-12		CFC-113		Halon-1211		Halon-1301	
	Excise	Floor	Excise	Floor	Excise	Floor	Excise	Floor	Excise	Floor
1990	1.37	1.37	1.37	1.37	1.096	1.096	0.00	0.00	0.00	0.00
1991	1.37	0.00	1.37	0.00	1.096	0.00	0.2466	0.2466	0.2466	0.2466
1992	1.67	0.30	1.67	0.30	1.336	0.24	0.2505	0.00	0.2505	0.00
1993	3.35	1.68	3.35	1.68	2.68	1.344	0.2505	0.00	0.2512	0.00
1994	4.35	1.00	4.35	1.00	3.48	0.80	13.05	12.7998	43.50	43.2488
1995	5.35	1.00	5.35	1.00	4.28	0.80	16.05	3.00	53.50	10.00

Source: U.S. EPA (1994).

See also: U.S. Treasury, Internal Revenue Service (1992).
Alliance for Responsible Atmospheric Policy (1994).

There is a risk, however, that the escalating floor tax will encourage early or inefficient use of 1994-95 production. Rushing to use the 1994-95 output would not be advisable for two reasons. First, if ozone depletion is worse than anticipated (so that substantial environmental benefits would result from destruction of existing ODS stocks), and/or destruction technologies become cheaper, it would be globally advantageous to have delayed some ODS consumption so that more of the ODS stock can be destroyed. (See Section III-B below.) Second, early use of the 1994-95 output caused by the escalating tax might run counter to the time profile of use that would be dictated by efficiency considerations based on the service requirements of different vintages and types of equipment. The tax could come into conflict with the optimal intertemporal allocation of the remaining ODSs. In addition, imposition of the floor tax on ODSs that are held for sale but not on those that are held for use could inhibit trading that would allocate the ODSs to their most highly-valued applications.

As the stock of ODS-using equipment is retired, the pre-tax price of ODSs would eventually fall to zero because there would be no further demand for them. Maintaining a high level of tax may mean that some ODS-using equipment will be retired earlier than it would have been had the ODS not been taxed. This effect is not likely to be large, however, especially when compared to the urgency of getting recycling equipment and markets into operation. Also,

because not all countries are using taxes as an instrument of ODS phaseout policy, this effect will be relatively small on a global basis.

In some Article 5(1) countries, the use of taxes to create an incentive for recycling may be complicated by institutional barriers to altering existing tax laws and by problems of collection. In such situations, the most effective policy may be for governments to employ direct controls to reduce leakage rates, increase retrofitting, and encourage recycling. It is also possible that the 10-year grace period for Article 5(1) countries has fostered unwarranted complacency regarding the need to establish recycling infrastructure. Whatever the circumstances of particular countries, however, an important policy goal should be to create incentives for conservation and reuse of existing CFC stocks.

It is important that illegally imported ODSs not be allowed to undermine the recycling and reclaiming effort. In the U.S., the concern is that CFCs are being smuggled to evade the excise tax (*Global Environmental Change Report* 1994a; Hebert 1994), while in the E.U., it is alleged that some imports are fraudulently being designated "recycled," as feedstocks, or for "inward processing"⁸ (MacKenzie 1994). Such illicit trade adds to the chlorine and bromine reaching the stratosphere, and undercuts the reclaiming and recycling efforts of firms that are complying with the law. Efforts are being made in both Europe and the United States to address this problem (*Global Environmental Change Report* 1994d; *Environment Watch: Western Europe* 1994).

Good record-keeping and timely reporting of data are crucial to stopping illegal trade in ODSs. Trade in any kind of Protocol-controlled substance is not permitted between Parties and non-Parties. Accurate data on the ODSs that are produced by Parties is needed to detect whether newly-produced ODSs are being falsely labeled as "used" or "recycled." Thus indirectly, improving compliance with the reporting requirements of the Protocol would help promote recycling and the development of ODS banking.

B. Uncertainties Regarding Destruction.

A number of destruction technologies are under development. The Montreal Protocol Parties have designated (1) liquid injection incineration, (2) reactor cracking, (3) gaseous/flame oxidation, (4) rotary kiln incineration, and (5) cement kilns as approved destruction technologies (U.S. EPA 1993), but a number of other technologies are the subject of active programs of research and development. These include plasma processes (Sekiguchi et al. 1993; Deam and Vit 1992) and laser photolysis. Other methods that could be applied include absorbance, metals scrubbing, pyrolysis, wet air oxidation, and supercritical water oxidation (Jacobson et al. 1993).

8. "Under the IPR [inward processing release] system, material is allowed to be brought in duty-free for a limited period to have value added in some way (often simply through repackaging), provided that it is subsequently reexported....Officials say the customs figures indicate that CFCs brought in ostensibly for inward processing operations are then being officially imported. The imports show up in customs authorities' data because they are declared, but the imports are technically illegal because they have not received an import license from the Commission---a requirement apparently overlooked by customs officials" (*Environment Watch: Western Europe* 1994).

Canada has been researching the possibility of "transformation technologies" that would convert ODSs into other useful chemicals, and the European Union, the Dutch Ministry of the Environment, and AlliedSignal will sponsor construction in 1995 of a test plant for a process to convert CFC-12 into HFC-32 (*Global Environmental Change Report* 1994b).⁹

The decision about whether ultimately to destroy ODSs (or to destroy contaminated ODSs rather than reclaiming them) will depend on the scientific assessment of how much the existing inventory of ODSs would contribute to ozone depletion, and the effects of that depletion, weighted against the cost of destruction and premature obsolescence of ODS-using equipment. Enforcement costs and incentive effects will have to be factored into the calculation, as toothless mandating of destruction could have the unintended effect of encouraging surreptitious venting.

It should be stressed that banking of CFCs and halons will be socially valuable whether or not a destruction decision is made. If the decision is made not to destroy existing stocks of ODSs, then banking operations can increase the efficiency with which those stocks are used. If destruction is chosen, then banking would be valuable because (a) some of the material would already be collected at central locations, minimizing the costs of gathering and transporting it to the destruction facilities, and (b) the remainder of the material would be accounted for, so that it could be collected at minimum cost.

It is precisely these advantages that constitute a barrier to banking. Potential ODS bankers (both central holders and registrants) worry that making their stocks known in such a public way increases the risk that those stocks might be confiscated by the government should the science assessment turn worse. Banking is seen as increasing the risk of uncompensated loss of ODSs. For this reason, data on halon holdings in the United Kingdom are kept "commercially confidential" between the manager of the 'bank' and the owning companies (UNEP 1993a).

Presumably, the Protocol Parties would come to a decision to destroy existing stocks of ODSs only if it became clear that the threat to the ozone layer were greater than the loss from rendering otherwise serviceable equipment useless. But the value of the ODSs used to service such equipment is much smaller (in monetary terms) than the total value of that equipment. This means that if the destruction option were chosen, the additional cost of compensating ODS bankers for the loss of their stocks would be small relative to the cost of the equipment that would be lost through unserviceability. If governments could somehow guarantee that owners would be compensated for confiscated ODS stocks, should destruction be the preferred option later in time, banking would be encouraged.

There are, of course, problems with this sort of policy. First, it is very difficult for governments to make such long-term commitments. In democracies, administrations change as the electoral balance shifts. There is even less expectation of policy continuity if governments

9. UNEP has set up an Ad-Hoc Technical Advisory Committee on ODS Destruction Technologies, and the Technology and Economic Assessment Panel held a workshop in late 1993 to bring together experts to discuss the state of the art of ODS destruction (UNEP 1992, 1993c). Another such workshop is being planned for 1995 (Finkelstein 1995). The program for the 1994 International CFC and Halon Alternatives Conference also included a session on the disposal and destruction of ODSs (Alliance for Responsible Atmospheric Policy et al. 1994).

turn over for other reasons. Second, compensating ODS bankers for their loss in the event the destruction option is chosen raises an equity problem, because it is unlikely that owners of the equipment rendered obsolete by ODS destruction would be compensated similarly.

Nevertheless, the Parties should consider some sort of insurance guarantee to compensate ODS bankers in the event that their stocks have to be destroyed to protect the ozone layer.¹⁰ Efficient ODS banking would have social benefits greater than the gains that could be captured by the holders of the stocks. By reducing transactions costs and promoting efficient management of the existing quantity of ODS, banking can increase the economic security and lower the costs of all owners of ODS-using equipment during the transition. As in other cases in which market participants cannot capture all the gains from their activities, a subsidy is justified, particularly since in this case the subsidy need only take the form of an insurance guarantee, not a direct transfer of funds.

Just as the institution of deposit insurance strengthened national banking systems by making them less vulnerable to runs and crises, an "ODS Deposit Insurance" system would contribute to the establishment of ODS banking. This, in turn, would help minimize the costs and disruptions associated with the transition from ODS technologies to alternatives. Participants in the ODS banking system would be rewarded for their cooperation by being insured, and ODS-using equipment owners would benefit from the lower costs and increased liquidity of markets for recycled ODS. An ODS Deposit Insurance system is a very low cost way the Parties to the Protocol could improve the efficiency, speed, and environmental effectiveness of the phaseout.

C. Standardization and Quality Control.

Even though recycled ODSs with their fungibility and low transport cost have many positive attributes for the development of a market, success is by no means assured. Seemingly trivial decisions about the definition of the standardized commodity or the setup of the market can matter, and the outcome can be a market that works well versus one that works not at all. The recent experience of the mung bean market on the Zhengzhou Commodities Exchange in central China is an example. The provincial authorities, wanting to encourage the use of organized markets for forward contracts, spent substantial sums developing a state-of-the-art computer trading system, accrediting local warehouses, defining rules for delivery, etc. They followed the international standards for the commodity to be traded, which included the stipulation of a maximum 15% moisture content. Unfortunately, the region's mung beans at harvest time have a slightly higher moisture content, which does not truly matter because central China's dry winters remove the excess moisture by springtime. In November 1993, when many traders brought truckloads of mung beans from some distance to the warehouses at Zhengzhou to deliver on their forward contracts, their mung beans were declared out of grade. These traders were forced to default on their contracts, for which there was a penalty, and to sell their mung beans at a discount to better-positioned traders. Worse, the organized market as a whole was

10. Mandatory destruction expenses incurred by Article 5(1) countries would be eligible to be covered as incremental costs by the Multilateral Fund.

discredited, and for a while trade there reverted to private deals until the contracts' provisions were changed (Williams 1993).

In the case of CFCs, a minor issue that might magnify into the success or failure of the trading system as a whole is the size of the cylinders in which the CFCs are stored and exchanged. Some users want large reusable 100 pound cylinders, while others prefer the smaller disposable 30 pound cylinders. At the moment, the large majority prefers the 30 pound cylinders. It may be, however, that those users remaining in a few years will prefer the larger cylinders. If so, any decision now to standardize trade in the 30 pound cylinders may discourage organized trading in a few years. More generally, the current system of trading, if it is to be set for all time, must forecast standards desired in the future. The wisest course may be to encourage standards but have provisions to review and revise those standards.

More problematic than the size of cylinders is the purity of the recycled CFCs. Individual users, unless they possess the most sophisticated testing devices, cannot determine the exact chemical makeup of the contents of a cylinder. Indeed, some replacement refrigerants and blends are designed to reproduce the vapor pressure gradient of the existing refrigerants, checking of which is the main simple test. Individual users may not even be able to tell that a chiller or air conditioning system has failed prematurely because the refrigerant most recently installed was contaminated. There is considerable worry in the mobile air conditioning industry that "system contamination is already occurring, and without Federal mandatory retrofit fittings and labels, contamination of the entire fleet and the recycle programs will occur" (Atkinson 1993). Given such concerns, recycled and reclaimed CFCs may acquire a reputation that leads most users to avoid them. Even if the consequences of impure CFCs are not this disastrous, the likely result is that users will gravitate towards the few servicing firms that can guarantee quality, by length of time in the business, by some long-term servicing contract with insurance for system failures, by formal bonding, or other such means. Any of these approaches for ensuring quality CFCs is likely to be more expensive than a credible grading system for the CFCs when they are placed in the cylinders. Expensive quality control guarantees will also have the effect of making the trading in CFCs more cumbersome, which in turn makes the allocation of the CFCs among users less efficient.

Thus, it is very important for the development of a market in stored CFCs to create a method for grading the contents of the cylinders. Perhaps some seal for the cylinders could be devised that if not broken would guarantee purity. Possibly reclaimers could be certified as purifying to the standard. (Some silver recyclers are accredited, with the result that their bars of .999 bullion are accepted without an expensive and time-consuming assay.) In the United States, agreement on standards of purity for recycled CFC-12 led to a billion-dollar market for recycling machines that were later mandated by law (Andersen 1994).

This area of grading and certification of grades is a logical place for government intervention, because there are more than private benefits to a credible grading system. Even the Chicago Board of Trade, where the individual traders are rarely accused of acting other than in their individual interests, first required, in the 1850s, the collective effort to establish and

implement grain grading before grain could be traded with the ease of warehouse receipts. (Later the State of Illinois, and then the U.S. Government, took over grain grading.) None of these grain grading systems has been operated to make a profit, but rather to reduce the costs of transactions. Under the circumstances for CFCs, it might well be justifiable to subsidize a grading system.

IV. CONCLUSIONS AND POLICY RECOMMENDATIONS.

The regulatory prohibition against future production of ODSs has transformed those commodities into the equivalent of non-renewable natural resources for which the principal economic issue is the allocation of the remaining stock over time. Even isolated users with their private stockpiles must make the difficult choice of using their limited reserves in the present or saving them for the next period (again to face the decision), all the while balancing the uncertainty of running out of supplies prematurely against the uncertainty of some inexpensive substitute's becoming available. A market connecting isolated users can only help improve these decisions, allowing each holder of stocks to judge the collective need for ODSs currently versus the future. A market among those holding ODSs not only gets the substances to their most valuable use within each period but, ideally, balances the current period with future periods. The better such a market functions, the more sensible will be the time profile of the drawdown from the remaining stocks of ODSs. In the extreme, lending arrangements that allow one user to take ODSs from a central depository in an emergency while promising to return the equivalent later---banking in its most natural sense---would enable the whole system to make do with fewer reserves.

A well functioning market in stocks of ODSs reduces the political pressure from individual users to relax the constraints on new production. An explicit value on ODSs will also encourage conservation and recycling, for no one wants to waste thousands of dollars worth of CFCs or halons in a false alarm or during the failure of poorly maintained refrigeration equipment. Because of this signal to conserve, a well functioning intertemporal market would preserve much more ODSs, which would be desirable were an inexpensive destruction technology to become commercially available in the future. The relative scarcity of ODSs over time also guides, however small the incentive, the decision about the timing of replacing or retrofitting ODS-using equipment. Indeed, the path of prices for ODSs should itself reflect the collective result of these decisions about replacement and retrofitting. In short, the prohibition of future production has made intertemporal price signals more important than ever before.

In the nature of markets, the more traders who use them, the lower the trading costs for everyone and the more representative the price signals. The lower the trading costs, the more people are inclined to use organized markets instead of relying on their own reserves. For example, more recycling of CFCs would encourage a loan market, a loan market would encourage recycling and maintenance, and so on. These positive feedbacks reduce the costs of the phaseout of CFCs. Anything that would encourage the existing clearinghouses and notice

boards for halons, and the incipient central depositories and lending facilities for CFCs, would improve the time profile of the use of those ODSs.

Regulatory uncertainty, particularly fear that it might ultimately become necessary for environmental reasons to destroy the remaining stocks of ODSs, inhibits the evolution of efficient ODS banking and recycling markets. Those holding stocks in highly visible locations such as a central depository worry that their stocks will be confiscated (in effect) by a new prohibition on use and/or they will be made to pay for the destruction. It is important to recognize that such concerns increase the current use of ODSs and leave less that could be destroyed in the future. Unlike the circumstances when new supplies are produced each year and uncertainty influences only the price in that one year, uncertainty about all future periods manifests itself in current prices, through the connection of storage. The prohibition of future production, which has transformed ODSs into stored commodities, has magnified the effects of any uncertainty about future regulatory actions.

Finally, uncertainty regarding the quality of recycled ODSs and the volume of legitimate trade in recycled ODSs threatens to undercut the prices received by those who have stored. Equally important, the damage to complicated equipment from impure ODSs could discredit all reclaimed and recycled material.

Fortunately, policies are available that can address each of these concerns in a constructive manner. The following recommendations would, in the view of the Economic Options Committee, contribute to reduction of the global cost of the ODS phaseout by promoting the emergence of a well-functioning system of ODS recycling and banking.

- (1) *Parties should reassure the operators of ODS banking operations that the evolution of those operations in the direction of becoming full-fledged markets will not be viewed as a violation of competition policy.* ODS clearinghouses should be permitted to handle price information and to function in ways similar to the operation of other organized commodity markets. There should be no regulatory barriers to the development of futures markets in ODSs.
- (2) *The Parties to the Protocol should institute "ODS Deposit Insurance" appropriate for their various legal and institutional frameworks.* This sort of deposit insurance, which would protect depositors in ODS banks from "crises" that might be precipitated in the future by new scientific information on the risk to the ozone layer, would encourage recycling and the development of high-efficiency ODS banks. The cost to taxpayers of ODS Deposit Insurance would be zero if destruction of ODS stocks were never to become necessary; if the destruction option must be chosen in the future, the cost of the insurance will be outweighed by the environmental benefits of avoiding increased atmospheric chlorine loadings.
- (3) *If Parties choose to use taxes as one of the instruments of accomplishing the phaseout and encouraging recycling of ODSs, then attention should be paid to making sure the taxes are not self-defeating.* That is, taxes should encourage recycling, not discourage it; taxes should not create an unintended incentive for venting of ODSs; and taxes should be designed to produce a minimum of distortion of the efficient intertemporal pattern of ODS use.

(4) *Data reporting should be treated as an essential component of Protocol compliance.* Not only will this focus the attention of the Parties on the tasks they must undertake to phase out ODSs (this is one of the reasons the Multilateral Fund emphasizes the submission of a country program as the first step in obtaining aid to meet incremental costs), it will contribute to recycling and banking by providing information needed to prevent the mislabeling and smuggling of newly-produced ODSs. In conjunction with bringing data reporting up to Protocol standards, the Parties should explore ways in which their customs services can become more adept at detecting and interdicting illegal trade in ODSs.

(5) *Parties should explore ways to assure the quality and standardization of reclaimed and recycled ODSs.* Just as food inspection and grading facilitates both internal and external trade, a system of certification of the purity of recycled ODS would make it easier for owners of ODS-using equipment to obtain the material they need for servicing. ODSs, because of their fungibility, low storage costs, and low transport costs are naturals for the development of intertemporal markets, provided traders can have some assurance about quality. Regulation can have a positive effect by providing testing and accreditation for recycled ODSs.

No doubt there are additional policies, specific to the circumstances of individual Parties to the Protocol, that would also encourage recycling and banking of ODSs. Such local initiatives should also be pursued. What is clear to the Economic Options Committee is that, given the urgency of the need to phase out production of ODSs, recycling is the key to a smooth transition to alternative technologies. ODS banking can make a substantial contribution to the recycling effort, and should be fostered by the kinds of policies listed here. Governments have an opportunity, by promoting the emergence of efficient ODS banking, to protect the short-term economic interests of their citizens while enhancing the effectiveness of their participation in the global effort to preserve the ozone layer.

APPENDIX A**Assumptions and Calculations Underlying Tables 7.1 and 7.2.**

This Appendix lists definitions of the variables and categories used in Tables 7.1 and 7.2, and the sources, assumptions, and calculations underlying those tables. All CFC quantities shown in Tables 7.1 and 7.2 and in this Appendix are in metric tonnes unless otherwise indicated.

1. Description of Categories.

In use: Tonnes of CFC in existing machinery during the given year.

Retired: Tonnes of CFC taken from machinery which has reached the end of its estimated life cycle.

From Retrofits: Tonnes of CFC taken from machinery retrofitted for use with non-CFC substances.

Net Recycled: Tonnes of usable CFC recycled from retrofitted and retired machinery.

Service Needs: Tonnes of CFC needed annually to refill CFC lost due to leakage.

Available: Tonnes of CFC in storage, banking, or recycling facilities.

2. Input Parameters.

ODS: Ozone depleting substance type.

Equipment type: Type of equipment using given ODS.

Initial CFC stock: Tonnes of CFC in use in equipment as of 1994.

Equipment life: Estimated lifetime of equipment in years.

Leakage rate: Fraction of CFC in use leaking to the atmosphere per year.

Retrofit rate: Annual rate at which CFC-using equipment is retrofitted for use with non-CFC substances.

Recovery rate: Fraction of CFC taken from retired and retrofitted machinery that is recycled and reused.

Production (CFC-11): Estimated global production for 1994 and 1995, excluding production in Article 5(1) countries operating under the 10-year grace period.

Net Production (CFC-12): Estimated global net production for 1994 and 1995, excluding production in Article 5(1) countries operating under the 10-year grace period (see below).

3. Equipment types.

Commercial Chillers: Also called Industrial Chillers by some sources.

Commercial Refrigerators: Includes grocery store refrigerators and refrigerated compartments for transport on trucks, trains and other means of shipping perishable goods.

Mobile A/C Systems: Includes air conditioning units in cars, trucks, buses, boats and other means of transportation.

Domestic Refrigerators: Household refrigerators.

4. Computations.

In Use:

(a) begins as initial CFC stock;

(b) after the first year,

$\text{In Use} = (\text{previous In Use}) - (\text{previous Retired}) - (\text{previous From Retrofits})$

In the case of CFC-12 each equipment type is calculated separately and the results are then combined.

$\text{Retired} = [(\text{Initial stock}) \times (1 - \text{Retrofit rate})^{(\text{Year} - 1993)}] / \text{Lifetime}$

In the case of CFC-12, each equipment type is calculated separately and the results are then combined. After a number of years equal to the Lifetime has past, all equipment of that type is considered to be retired. The base from which the number of machines to be taken out of service is computed is reduced each year to account for all retrofits performed to that date. (This avoids double counting the retirement of previously retrofitted equipment.)

From Retrofits = (In use) x (Retrofit rate)

In the case of CFC-12, the figure for each equipment type is calculated separately and the results are then combined.

Net Recycled = (Retired + From retrofits) x (Recovery rate)

In the case of CFC-12, the figure for each equipment type is calculated separately and the results are then combined.

Available = (Production) + (Net Recycled) - (Service Needs)

Special Case: Mobile A/C Systems

In Table 7.2, the calculations were modified to account for the plausible real-world assumption that mobile air conditioning systems are not likely to be serviced during the last three years of vehicles' useful lives. These modifications change the computation of In Use, From Retrofits, and Service Needs.

CFCs In Use were disaggregated into the 14 production years (1981-1994) of cars with CFC-using air conditioning systems. Rather than applying the retrofit, servicing, and retirement rates to a single In Use figure, each automobile model year is treated individually. CFCs are simply assumed to leak out without being replaced during the last three years of a car's life; retrofit rates are applied only to systems which are still being serviced; and all remaining CFC stocks of a given production year are retired after 14 years of the automobile's life.

5. Derivation/Source of Input Parameters.

Lifetimes:

<u>Source</u>	<u>Equipment</u>	<u>Estimate</u>
(CRS, p. 4)	Domestic Refrigerators (15-20 years)	20 years
(Authors' estimate)	Mobile Air Conditioning	14 years
(Authors' estimate)	Commercial Refrigerators	20 years
(Authors' estimate)	Commercial Chillers	30 years

Note: The Congressional Research Service (CRS) estimates the lifetime of automobiles in the U.S. to be 10-12 years. A more plausible 14 year lifetime was

assumed in Table 7.2, partially to account for longer service lives of automobiles globally.

Initial Stocks (Worldwide):

Mobile A/Cs

(Vogelsberg, p.908)	265,000,000 (Autos & Trucks)
	250,000 (Buses)
	75,000 (Pas. Rail Cars)
	+ 33,000 (Ships)
	<hr/>
(computation)	265,358,000 (Total Units)
(CRS, p. 5) U.S. autos with A/C	= 100 million
U.S. CFC inventory in autos	= 200 million pounds
(computation)	= 2 pounds CFC per auto
(computation)	
(2 pounds/unit) x (265,358,000 units)	= 530,716,000 pounds CFC in MAC
	= 240,945 tonnes
(rounded to)	250,000 tonnes

The figure for initial MAC stock was rounded up considerably to account for the larger quantities of CFCs used in non-auto mobile A/C systems as compared to auto A/C systems.

Commercial Chillers

(Vogelsberg, p.908)	112,000 Industrial Chillers
(CRS, p. 5) U.S. Commercial Chillers	= 67,000
CFC in U.S. Chillers	= 80 million pounds
(computation)	= 1,194 pounds/unit
(rounded to)	1,200 pounds/unit

(computation)

$$(112,000 \text{ units}) \times (1,200 \text{ pounds/unit}) = 134,400,000 \text{ pounds}$$

$$= 61,018 \text{ tonnes}$$

(rounded to)

$$= 61,000 \text{ tonnes}$$

Commercial Refrigeration

(Vogelsberg, p.908)

2,000,000 (Commercial Refrig.)

800 (Cargo Ships)

300,000 (Sea-Land)

1,000,000 (Large Refrig. Trucks)

75,000 (Refrig. Rail Cars)

(computation)

3,375,800 units

(CRS, p. 5)

U.S. Commercial Refrig.

= 2-3 million units (2.5 million)

U.S. Com. Refrig. Inventory

= 50 million pounds CFC

(computation)

= 20 pounds/unit

(computation)

$$(3,375.800 \text{ units}) \times (20 \text{ pounds/unit}) = 67,516,000 \text{ pounds}$$

$$= 30,652 \text{ tonnes}$$

(rounded to)

$$= 31,000 \text{ tonnes}$$

Domestic Refrigeration

(CRS, p. 5)

U.S. inventory in Refrigerators = 80 million pounds CFC

(approximation) 1/4 of world total in US

= 320 million pounds (world total)

$$= 145,283 \text{ tonnes}$$

(rounded to)

$$= 150,000 \text{ tonnes}$$

Leakage rates:

(CRS, p.5)	Commercial Refrigeration	22-25%
	Commercial Chillers	<10%
	Domestic Refrigeration	2-4%
	Auto Air Conditioning	15-25%

(rounded to)	Commercial Refrigeration	.24
	Commercial Chillers	.08
	Domestic Refrigeration	.03
	Auto Air Conditioning	.20

Retrofit rates:

These rates are subject to economic incentives and behavioral change. For purposes of the calculation, authors' estimates were used. One source, (Hubbard 1994) estimates that at an "accelerated" conversion rate it would be possible to convert or replace existing CFC-11 chillers in 7 to 8 years. This would be consistent with a maximum retrofit rate of about 13%.

Recovery rates:

These rates are subject to economic incentives and behavioral change. For purposes of the calculation, authors' estimates were used (see text on MACs). The 1991 *Report of the Refrigeration, Air Conditioning and Heat Pumps Technical Options Committee* estimated that 33% of the refrigerant previously lost during repair and disposal of industrial refrigeration systems will be recovered by 1995, increasing to 67% by 2000. This same *Report* estimates 70% recovery for CFCs in developing country heat pump applications (UNEP 1991, pp. 123, 189). The Automotive Consulting Group (ACG) estimates that 0.22 kg. of CFC-12 will be recovered from each vehicle scrapped (1993). This is consistent with our estimate of a recovery rate of 50%, given no servicing of the A/C over the last three years of the vehicle's life. The ACG estimates a higher recovery rate for retrofitted automobiles. In principle, the recovery rate at disposal can approach 100%, being less than that figure only to the extent that scrapped equipment cannot be completely purged of CFCs and that some of the recovered material is lost when it is purified for reuse.

Production:

(1) Total allowable CFC production in 1994 was computed as 25% of Montreal Protocol Baseline production (UNEP 1993b) for non-Article 5(1) countries other than countries belonging to the E.U., and 15% of Baseline production for E.U. countries (Kruse 1994).

(2) Total CFC production for 1995 was computed as 25% of Montreal Protocol Baseline production for non-Article 5(1) countries other than countries belonging to the E.U., and zero for E.U. countries (Kruse 1994).

(3) 1994 production of CFC-11 was set at 25,000 tonnes, approximately 1/8 of total CFC production. 1995 production of CFC-11 was set at zero.

(4) Production of CFC-113 was assumed to be 10% of the 1994 allowable and 5% of the 1995 allowable figures. CFC-113 was about 20% of 1986 Baseline production (Ozone Secretariat 1993) and about 17% of U.S. CFC production in 1989 (Smithart 1993). The lower percentages of CFC-113 production in 1994 and 1995 reflect the speed at which the phaseout of this chemical is taking place.

(5) 3,000 tonnes of CFC-12 production in 1994 and 1,500 tonnes in 1995 were assumed to go into newly-produced domestic refrigerators. The 1994 figure is based on 5% of the existing stock (for replacement) in 1994 and half that amount in 1995 as non-CFC new refrigerators begin to reach the market. It is assumed that the non-Article 5(1) countries will no longer use CFC-12 in new domestic refrigerators after 1995. All other new equipment was assumed to be CFC-free.

(6) 6,000 tonnes of CFC-12 were assumed to be used in Metered Dose Inhalers (MDIs) in 1994 and 1995 (UNEP 1993a). The amount in MDIs after 1995 was assumed to be exactly equal to new production allowed under essential use exemptions granted after that date.

6. Sources.

See References at end of Chapter. CRS is the report on the CFC phaseout published by the Congressional Research Service (Gushee 1993). Vogelsberg (1993) cites the UNEP December 1991 *Report of the Technology and Economic Assessment Panel*.

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CHAPTER 8**TRANSFERABILITY OF THE MONTREAL PROTOCOL EXPERIENCE
TO OTHER****INTERNATIONAL ENVIRONMENTAL AGREEMENTS****I. INTRODUCTION.**

Although there are currently over 140 international agreements dealing with environmental concerns, the Vienna Convention for the Protection of the Ozone Layer (1985) and the Montreal Protocol on Substances that Deplete the Ozone Layer (1987) and its subsequent amendments in London (1990) and Copenhagen (1992) hold a distinctive place in the spectrum of international environmental agreements (IEAs). Generally, IEAs deal with specific problems or regional issues of significance. The Montreal Protocol was the first attempt to come to deal with a global problem. The Montreal Protocol process has many lessons for those negotiating new IEAs. These lessons must necessarily be qualified to reflect the nature and characteristics of the environmental problems under consideration if they are to be meaningful and effective. In this chapter an attempt has been made, on the basis of a critical appraisal of the Montreal Protocol process, to reach constructive conclusions for the negotiation of other IEAs.

The negotiations for the Montreal Protocol brought to the surface, for the first time in international discussions, the urgency of environmental problems. The scientific analysis of the causes of the depletion of the ozone layer were assessed, the physical and socio-economic consequences of the depletion were identified, and the urgent need for remedial action on a global level accepted. The sense of urgency reflected a global unease that large problems were emerging as a result of the mismanagement of natural resources, trans-boundary pollution and the generation of toxic wastes, and the overloading of the assimilative capacities of natural systems.

The international momentum for the successful completion of the Montreal Protocol process, particularly during the period between the approval of the Protocol in 1987 and the signing of the momentous London amendments in 1990 is not generally known or appreciated. The Ad Hoc Working Groups established to identify, assess and negotiate contentious issues worked hard and with united determination to produce credible results. It is to be hoped that a similar spirit and sense of dedication will mark not only the resolution of the implementation problems in those countries operating under Article 5(1) of the Protocol but also those other, perhaps more complex, global environmental challenges that lie ahead.

The Montreal Protocol process was driven by the realization that it would be unrealistic to expect uniform responses from all Contracting Parties and thus a sophisticated international regulatory regime was needed. Such a regime would have to take account of a number of factors, including the legislative frameworks of those countries prepared to implement an international environmental agreement, the policy instruments that could be used for the purpose, the technical and organizational information systems available for ODS phase-out, public awareness of the nature of the commitments undertaken, and, above all, the institutional capacity to implement the measures required to comply with the commitments that are accepted by becoming a Party to the Montreal Protocol.

Some aspects of the problems faced by the Montreal Protocol process were dealt with more successfully than others for various reasons. But these different aspects yield valid lessons with respect to the difficulties that arose during the negotiations and to the procedural and substantive approaches that were employed to meet them. It is equally instructive to examine the early recognition of critical issues and the attention paid to them from the beginning of the negotiations.

One aspect to which insufficient attention was paid in the early stages of the Montreal Protocol process relates to the question of the "right mix" of measures (e.g. information exchange, training, investment projects, economic incentive structures to expedite implementation of phasing-out of ODS operations, etc) that should be tailored to the needs of individual countries. During the Montreal Protocol process this question was indirectly and implicitly, but not explicitly, addressed. If the issues had been addressed properly, guidelines could have been established. In their absence, the Multilateral Fund has had to develop operating procedures in the difficult and critically important field of implementation policy whilst being stretched to deal with day to day management decisions. It will be seen that the origin of this problem was "design fault" compounded by the initial difficulties of establishing an operational Multilateral Fund Secretariat and its working arrangements with the implementing agencies. The international community is still struggling with the consequences of this design fault, not least with a new, small and relatively inexperienced Secretariat trying to "manage" large, powerful and established international institutions in pursuit of the cost-effective implementation of the Montreal Protocol in the Article 5(1) countries.

Similarly, there was a lack of early attention to implementation problems (which were considered during the Montreal Protocol process to be a "second generation" issue). There was, thus, no attempt made during the negotiations for the Montreal Protocol or any of its subsequent amendments to define the key elements that should underline policy development e.g. inter-relationships between instruments to create a consistent and effective framework of economic incentives or a typology of instrument use by country type defined in terms of ODS production and usage or the identification of barriers to progress in information exchange, establishment of mechanisms to evaluate progress and make recommendations in this important field, or, for that matter, a careful analysis of certain technical issues, such as, "destruction technologies", "alternative disposal technologies", etc. that could be expected to come on stream in the future. It would also have been helpful to distinguish the different categories of Article 5(1) countries in a more explicit way. Country characteristics, such as, status as importer versus producer of ODS, low versus high ODS consumption, export versus domestic use of ODS and products containing ODS, etc., could have been used for the purpose thus laying the foundations for more meaningful analyses and cross-comparisons.

Finally, there was the neglect of remedial measures that already existed or could be expected to emerge over time. Little attention, for example, was paid to the implications of the Basle Convention or to the prospects of ODS banking on phaseout schedules.

There are both (a) general and (b) specific lessons from the Montreal Protocol process that could be transferred, with benefit, to the negotiation of other IEAs.

II. General Lessons.

One general element which deserves consideration in the negotiation of other international environmental agreements relates to the early and common acceptance of the applicability of the experience gained by the industrialised countries to the design and implementation of phaseout regimes in the Article 5(1) countries. This was a result of the tapping of the "Porter hypothesis" (Porter,...) namely, that creative responses to environmental regulatory pressures are but one example of the more broad-based capacity of successful firms to respond to market challenges. Ultimately there is a trade-off between responding to environmental regulations and meeting other market challenges but there was an early awareness in UNEP, as among a number of negotiating countries, during the Montreal Protocol process that the capacity for creative responses to ODS phaseout would eventually lead to a reduction in compliance costs relative to initial estimates. This was, of course, predicated on the assumption that the benefits of the environmental regulations in question justify the costs of such actions in terms of an overall increase in economic (or social) welfare.

At the same time, the preparatory processes as well as the actual negotiations leading to the Montreal Protocol and its subsequent amendments highlighted the need to strike a balance between national interests and the global well-being. It was seen that in this effort, nations, both large and small, must take part in a common endeavour to address shared environmental problems _ those that go beyond the borders of nations and cannot be properly solved by any one country or group of countries.

Another consideration that was generally accepted was the need for a multi-disciplinary and multi-faceted approach to international environmental challenges. It was considered essential to bring together scientists, industrialists, economists, engineers, environmental activists and political decision-makers. Science and industry, for example, have had a pivotal role in the process of negotiating not only the Montreal Protocol but also in the establishment of the Framework Convention on Climate Change and the Convention on the Conservation of Bio-diversity. When UNEP began negotiations leading to the Montreal Protocol, industry, including multi-national corporations (MNCs), were most helpful in providing experts, detailed data on global consumption levels of different types of ODS, and other supporting expertise.

One concern that was critical during the Montreal Protocol negotiations, and is currently plaguing the negotiations of other international environmental agreements, is the balance of scientific certainty on the causes and consequences of damages to natural systems. It was, however, concluded during the negotiations that environmental issues in general, and atmospheric conditions in particular, were rarely, if ever, blessed with scientific certainty - doubts and substantial margins of error in quantitative estimates persisted. The wise course,

in the circumstances, was to follow the precautionary principle. When UNEP first started to estimate future ozone layer depletion levels in the early 1970s, estimates varied widely from year to year. As the years went by the estimates became more sharply defined and by the summer of 1989 had confirmed that stratospheric ozone depletion was much worse than previously thought. Two years later, in September 1991, a scientific report prepared for UNEP by eighty of the world's leading atmospheric scientists concluded :

- (a) that the rate and scope of stratospheric ozone depletion was, indeed, far worse than previously estimated;
- (b) that depletion now covered North America, Europe, the USSR, Australia, New Zealand and a large part of South America in both spring and summer;
- (c) that thousands of people were at risk from skin cancer, eye cataracts, and a weakened human immunity system; and furthermore,
- (d) that increased UV radiation was contributing towards a stunting of plant growth and weakening the reproduction of phytoplanktons, the very basis of the marine food chain.

Since the 1991 international scientific assessment, a deeper understanding has evolved of the chemical changes in the atmosphere and their relation to the Earth's stratospheric ozone layer and the radiative balance of the climate through laboratory investigations, atmospheric observations, and theoretical and modeling studies (UNEP, Executive Summary of the Scientific Assessment of Ozone Depletion: August 1994). The key findings which further strengthen the links between human-influenced sources of chemical changes and stratospheric ozone depletion were that:

- (a) the atmospheric growth rates of several major ozone-depleting substances have slowed, demonstrating the expected impact of the Montreal Protocol;
- (b) peak total chlorine loading in the stratosphere is expected during 1997-1999;
- (c) record low global ozone levels were measured in 1992 and 1993 - in part due to perturbation associated with the volcanic eruption of Mt. Pinatubo in 1991;
- (d) downward trends in total-column ozone continues to be observed over much of the globe;
- (e) the Antarctic ozone "holes" of 1992 and 1993 were the most severe on record; and
- (f) the link between a decrease in stratospheric ozone and an increase in surface ultraviolet (UV) radiation has been further strengthened.

One issue that first arose during the negotiations for the Montreal Protocol but is now found to be common to other international environmental agreements as well is that if we want a global endeavour, based on global partnership, a shared global commitment is needed. One of the first, although not unexpected, concerns expressed by the Article 5(1) countries was that if they were expected to enter into legally binding commitments to phase out ODS within a specified timetable they must also have in return equally binding commitments to have the necessary technology or the financial resources made available to them.

The remedial framework for dealing with these two problems - namely, (a) the innovation and transfer of appropriate technology and (b) the transfer of financial resources to the Article 5(1) countries, which was considered essential for the ODS phaseout on a global scale - is at the heart of the Montreal Protocol and particularly its London amendments. What makes the Montreal Protocol a role model for subsequent international environmental agreements is the open and transparent way these issues were treated. The burden involved in the transfer of resources was considered as the first real test of whether the international community was truly prepared to enter into a global bargain designed to manage risks to the global environment. Nor was the flow of resources considered as additional aid or global philanthropy; it was regarded as an investment in survival.

In January 1991, the Multilateral Ozone Fund of up to US\$240 million over a three year period paid largely by industrialised countries and intended to provide financing for and to facilitate technology transfer to Article 5(1) countries - became operational. In many ways, it constitutes a basic bargain between the developed and developing countries on which future international environmental compacts would do well to build. For one thing, it shows that while the cost of remedial action - in terms of global emission targets, best available technology, and comprehensive consumption strategies - could be high, it is likely to be much less than the costs of delay or inaction.

One general concern which contributed a great deal towards the success of the Montreal Protocol process, was that any funding mechanism set up to deal with the transfer of resources to the Article 5(1) countries must be democratic, transparent, and not tilted in favor of one or the other groups. The discussions, often acrimonious, that are currently in progress in terms of the institutional arrangements, decision-making procedures, and the allocation of resources in the prospective management of the Conventions for Climate Change and Conservation of Bio-diversity as well as the Global Environmental Facility itself reflect built-in conflicts that can arise when the lessons learned so painfully during the Montreal Protocol process are ignored.

This is not to endorse all the institutional arrangements initiated by the Montreal Protocol. A distinction must be made between what is politically viable and what is economically efficient. Two issues arise in the consideration of economic efficiency in the context of the implementation of the Montreal Protocol. First is the question of "benefits" from the Multilateral Fund disbursements. Benefits were never discussed during the Montreal Protocol negotiations except in such broad political terms as the advantages of ODS phaseout or the successful conclusion of an international agreement (which are not quantifiable) and certainly not estimated in a cost-benefit framework. Nor would it be desirable to do so now. Second, political issues cannot be solved by appealing to economic arguments.

One aspect of the Montreal Protocol institutional arrangements which is weak and cannot be recommended for transferability relates to the Secretariat of the Multilateral Fund. This is the result, in large part, of structural design failures; it does not constitute a reflection on the performance of the Secretariat within the existing structures.

III. Specific Lessons.

The international regulatory regime was based on the perception (new in 1990) that the Montreal Protocol process would inevitably generate a set of organizational adaptations which would be as important and effective as the technological innovations. This perception has been found to be valid not only in industrial countries but in many Article 5(1) countries as well. Retrofit technologies are a case in point. Without appropriate organizational back-up the conversion from ODS would have been difficult, more costly, and prolonged. Furthermore, anticipated changes down the time-path (and well into the future) act as powerful incentives in this process of accelerated conversion.

In the negotiations leading to the London Amendments (1990), several developing countries came to UNEP to express their deep concern over what they called the "indirect" costs to their economies of compliance with the international regulatory regime and sought relief both in terms of technical assistance and financial support. This led to a greater understanding of the "transaction costs" involved in eliminating ODS, notably, building up public awareness within the country, education and training within the industry, making a survey of who are the users of ODS and at what level, and the overcoming of delays in project investment once a changeover has been decided. It is these considerations that lay behind the creation of the Multilateral Fund. But although the Multilateral Fund was created for the right reasons, (a) it was not given the proper level of funding to meet both the transaction costs and the incremental costs especially when the investment barriers to the application of new technology became higher and the crunch comes (i.e. the period about to begin) and (b) its Secretariat, as already noted, was denied effectiveness because of structural design failures.

Generally speaking, the regulatory regime embedded in the Montreal Protocol process is based on performance standards, that is to achieve a level of ODS elimination irrespective of the technological means employed. There were those during the negotiations who would have preferred "command and control" approaches that often specify the technological means to be employed. Fortunately, this route was not taken. The Montreal Protocol provides a regulatory framework which encourages innovation to meet phaseout targets and has a built-in incentive to search for cost-effective technological alternatives to ODS usages.

In considering the transferability of the Montreal Protocol experience it is worthwhile to keep in mind certain policy-driven aspects. One such aspect relates to the role played by scientific research and technological innovations in securing breakthroughs when problems related to products and processes had seemed at first encounter to be intractable. For instance, it was commonly agreed, almost accepted as conventional wisdom, a few years ago that the use of CFC 113 as a solvent in the electronic industry could not be changed and, thus, there were grounds for its exclusion from the list of controlled substances. But further research (by industry itself) showed that ODS solvents could be eliminated in the high-tech electronics

industry _ especially as the life of the products was short. There is a lesson here (that is to say the careful examination of the kind of attention paid by the industry to research and the life-time of the products) from the Montreal Protocol experience which needs to be kept in mind, both by governments and industry: the solutions sought should be industry and product specific.

There is another lesson from the Montreal Protocol experience which is equally valid: a judicious use of carrots (higher profits through technological breakthroughs) and sticks (the prospect of elimination of CFC production) to drive the engine of both technological innovation and organizational efficiency. It is only necessary to review the new technologies and management changes currently deployed in the field of ODS elimination to see the potency of the international regulatory regime that was put in place by the Montreal Protocol.

For industries that are less research-orientated or have products with longer lifelines, it becomes necessary, in terms of the Montreal Protocol experience, to pay close attention to two aspects of the changes sought: the changes should be at minimum cost and with the least industrial disruption. If the perception is that the international environmental agreements in the making do not have or foster these objectives, there will be little willingness on the part of governments or industry to co-operate. But costs and industrial disruption cover a large canvass and require judicious attention to such problems as transitional regimes, uncertainty and indecision in regulatory frameworks, and long-term development goals, especially for the Article 5(1) countries.

It is equally necessary to ensure that change, innovation, and replacement of technology are not carried out by huge government bureaucracies but by existing business units. This will, of course, not be possible in all Article 5(1) countries but a careful mix of regulations and co-operation between the public and private sectors is in order whenever and wherever possible.

In evaluating the Montreal Protocol experience, attention must necessarily be paid to the role of the Multilateral Fund in providing assistance to the Article 5(1) countries. Clearly, such assistance must be based on objective estimates of need arising from (a) the preparation of phase-out strategies for the country concerned and (b) the incremental costs involved in them. A practical way to develop such national strategies is to estimate, in terms of different scenarios, the rates of growth of demand for the relevant products and the costs (and availability) of ODS substitutes. These issues have been discussed in detail in Chapter 3. Incremental costs remain an imprecise concept. Estimates of incremental costs in the country case studies undertaken so far vary widely possibly because of differences in the specification of the baseline scenarios.

As related in Chapter 4, the great variety of procedures to deal with the phaseout of ODSs offers many specific elements with a high prospect for transferability. It is for the national governments to ensure that commitments made in ratifying the Montreal Protocol are implemented. These commitments are contained in the timetable for the phaseout of different ODSs and reporting on the action taken to the Contracting Parties. In assuming this legal responsibility, the Contracting Parties must ensure that at least some elements of the three main policy instruments have been put in place - namely, command and control measures,

economic instruments (i.e market mechanisms), and, finally, voluntary approaches. The lessons learnt in the Montreal Protocol process indicate:

- (a) that the different approaches are not mutually exclusive ie they could be used jointly;
- (b) that the approach must reflect the country's own legislative and fiscal culture, local industry circumstances, the speed at which ODS phaseout is to be achieved, the feasibility of enforcement, and the cost-effectiveness of alternative policy approaches; and
- (c) that the experience gained so far is rich in variety and content.

In a related field, the reliance placed during the negotiations on the Montreal Protocol and its Amendments on the need and procedures for monitoring compliance means that the Contracting Parties have accepted an obligation to report on their ODS transactions. This has not been an easy responsibility to meet, especially for the Article 5(1) countries. It required a modification of the Custom Code from describing chemicals according to their functions to a description based on their chemical properties. New sub-headings had to be added to the national statistical nomenclatures. This requires administrative regulations to check both on misreporting by importers and misrecording by Customs authorities.

Attention must also be drawn to the information exchange activities generated by the Montreal Protocol process. These activities are centered around UNEP IE/PAC OzonAction Programme and comprises the query response service, the on-line and diskette OAIC, the library, sectoral data collection projects and outreach activities. It was clear from the outset of the negotiations for the London Amendments (1990) that it would be necessary to respond effectively and efficiently to queries from users on both technical and policy subjects as the process of ODS replacement gathered momentum. What was not anticipated was the level and intensity of demand for the information services and their extensive use of mail, telephone, fax, telex, cable as well as through the message centers of the on-line OAIC. Another area of interest has been the demand for outreach activities to inform Article 5(1) countries of the information services available to them. Chapter 5 details the modus operandi of these programmes which have a significant element of transferability.

During the Montreal Protocol process certain specific problems arising from the impact of international trade on the regulatory regime for the replacement of ODS were also considered. Two sets of trade problems were considered during the negotiations for the Montreal Protocol. First, those that might arise from trade in ODS between non-signatory and signatory countries (keeping in mind the need to encourage non-Parties to become Parties to the Protocol). Second, those that might arise from the grace period extended to the Article 5(1) countries (to obviate a concern that industrial countries required to phase out ODS by 1995 might move production to Article 5(1) countries). Both sets of problems had to be contained in an effective manner if the ODS phaseout was to be on track. The trade strategies, which were highly sensitive in their remit, were largely successful in the realization of their objectives. Chapter 6 deals with the trade problems encountered in the Montreal Protocol negotiations and the solutions put in place together with the exemptions, compatibility with

GATT provisions, and related issues. Clearly, there are striking elements of transferability in dealing with trade questions, especially since these questions are likely to become increasingly important in the aftermath of the Uruguay Round, the creation of WTO, and the growing relevance of environmental issues in trade negotiations

A realization that has grown in recent years is that international agreements - particularly in the field of environment because of the strong inter-relationships that exist among natural systems and the common features of the regulatory frameworks they put into place - could be both compatible and mutually reinforcing. This opens up the possibility of developing international environmental agreements not considered to be feasible so far. Consider, for example, trade in ODS under the provisions of the Montreal Protocol and the Basel Convention on the Transboundary Movement of Hazardous Wastes and their Disposal. Clearly, the revised Basel Convention that lays down more stringent regulations on the movement of hazardous wastes also covers the transboundary movement of wastes of controlled substances. There are, however, as noted in Chapter 6, certain exceptions to such applications: it would be beneficial both to the implementation of the Basel Convention and the Montreal Protocol if such exceptions were to be maintained.

Considerable experience has now been gained, in the context of the Montreal Protocol process, with CFC and Halon banking. The intertemporal allocation of ODS stocks, including organizational arrangements which have strong elements of transferability both in their conceptual and operational aspects. Chapter 7 describes the mechanism in some detail and identifies its ramifications. The heart of the matter is that whenever we are dealing with products, processes or chemicals that (a) impact on the environmental well-being and (b) have become essentially non-renewable resources as a result of a phaseout of production, the possibility of devising an effective "banking" system becomes an useful and attractive option. Both technological and organizational breakthroughs are still needed but there is a strong impetus to realize them in the context of the replacement of the ODSs.

It will be seen that "banking" arrangements constitute a powerful incentive to recover ODSs in all forms except when leaked accidentally to the atmosphere. The frequency of such accidents is, of course, in itself a function of the monetary value of the ODSs. High prices for recycled ODSs as supply restrictions reduce virgin supplies creates an incentive for "banking" operations leading to greater attention being paid to reducing losses to the atmosphere through improved handling and equipment maintenance practices as well as to ODS recovery.

IV. Concluding Remarks

The negotiation of new international environmental agreements should be viewed as part of a cumulative learning experience in that full use should be made of the foundations already laid for such agreements. The distinctive aspect of the Montreal Protocol is that it was the first IEA to strike a politically feasible working balance between the scientific, technological and economic factors relevant to the achievement of an explicit global environmental objective.

The several chapters of this Report illustrate that there are many elements of "transferability" in the Montreal Protocol process that could be usefully incorporated in the design of new IEAs. Even so, the selection of which specific elements to transfer must be evaluated with respect to the experience already gained and also have regard to the specific characteristics, needs and constraints of the new IEAs in the making. In this way, we can continue to make steady progress up the "learning curve" associated with the design of IEAs, and thereby to develop progressively more efficient instruments for managing the risks to the global environment.

ADDENDUM:

METHYL BROMIDE AS A CONTROLLED SUBSTANCE UNDER THE MONTREAL PROTOCOL: ECONOMIC ISSUES

1. The decision of the Parties to list methyl bromide as a controlled substance under the Montreal Protocol has led to a number of studies addressing the economic costs and benefits of partial or complete phaseouts of its "consumption". The Chair of the Economic Options Committee, in consultation with EOC members and others, has prepared this Addendum based on critical appraisals of the studies listed as references.
2. The key issues are the economic costs and benefits of methyl bromide control options. Assumptions regarding the availability, cost, and effectiveness of alternatives to methyl bromide uses are major determinants of the effects of the various control options on economic welfare. Differences between national control options can influence trade flows with significant implications for consumer and producer welfare. The economic benefits of methyl bromide use controls are determined mainly by converting estimates of avoided damage to human health, associated with reduced ozone depletion, into monetary values. Both the cost and benefit estimates are subject to uncertainty. Methodological choices can influence the extent to which these estimates suppress or expose inherent uncertainty.
3. The key findings of this review are as follows.
 - All of the identified economic studies focus on the assessment of national costs and benefits. Some allow for the domestic effects of selected bilateral trade flows, but none seek to determine the respective costs and benefits for several countries engaged in multilateral trade.
 - In general, the assumptions used in many of these studies do not give adequate attention to the dynamics of technological change under regulatory stimulus. Experience with other ODS controls under the Montreal Protocol suggests that this deficiency leads to substantial overestimation of phaseout costs.
 - Most of the studies are based on phaseout scenarios that bear little or no relation to the current or prospective control regimes under the Montreal Protocol. In particular, studies based on assumptions of immediate phaseout and dependence on only those alternatives currently available generate results that have very limited relevance to likely costs and benefits of methyl bromide controls under the Montreal Protocol.

4. Suggested priorities for the next phase of economic studies on control options for methyl bromide are:

- the design of economically efficient control options consistent with the Montreal Protocol;
- assessment of the magnitudes and distributions of the costs and benefits between the Parties to the Protocol associated with the respective control options; and
- assessment of the economic feasibility and cost-effectiveness of technically feasible alternatives to specific methyl bromide uses.

5. The results of further assessment of all available relevant economic studies will contribute to the mandated TEAP Report to the Ozone Secretariat on methyl bromide control options scheduled for March 1995.

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APPENDIX C: GLOSSARY OF ABBREVIATIONS

AFEAS:	Alternative Fluorocarbons Environmental Acceptability Study
CAC:	Command-and-control measures
CIS:	Commonwealth of Independent States
EOC:	Economic Options Committee (UNEP)
ExCom:	Executive Committee of the Multilateral Fund of the Montreal Protocol
GATT:	General Agreement on Tariffs and Trade
GEF:	Global Environmental Facility
ICOLP:	Industry Cooperative for Ozone Layer Protection
IEA:	International Environmental Agreement
IE/PAC:	UNEP Industry and Environment Programme Activity Centre (UNEP)
IPR:	Intellectual Property Rights
JEMA:	Japan Electrical Manufacturers Association
JICOP:	Japan Industrial Conference for Ozone Layer Protection
MAC:	Mobile air conditioning
MBTOC:	Methyl Bromide Technical Options Committee (UNEP)
MeBr:	Methyl bromide
MF:	Multilateral Fund
NGOs:	Non-governmental organizations
ODS:	Ozone depleting substances
ODP:	Ozone depletion potential
OORG:	Ozone Operations Resource Group
TEAP:	Technology and Economic Assessment Panel (UNEP)
UNDP:	United Nations Development Programme
UNEP:	United Nations Environment Programme
UNIDO:	United Nations Industrial Development Organization
WB:	World Bank
WTO:	World Trade Organization

